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DESIGN OF A PICTURE LANGUAGE TO IDENTIFY VEHICLE CONTROLS
I. GENERAL METHOD
II. INVESTIGATION OF POPULATION STEREOTYPES

Samuel A. Mudd

Robert Karsh

December 1961

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SAMUEL A. MUDD

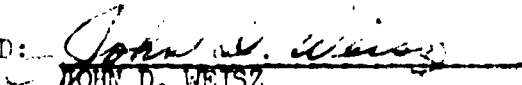
ROBERT KARSH

Technical Assistance

Warren Von Uffel

December 1961

APPROVED:


JOHN D. WEISZ
Director
Human Engineering Laboratories

U. S. ARMY ORDNANCE HUMAN ENGINEERING LABORATORIES
Aberdeen Proving Ground, Maryland

ABSTRACT

I. GENERAL METHOD

A general approach to the problem of developing a picture language or set of picture-symbols, as labels for equipment controls, is discussed. Negative and positive arguments for such a system of symbols and possible research strategies are considered.

II. INVESTIGATION OF POPULATION STEREOTYPES

The results of the first of a series of studies are reported. United States and foreign military personnel were asked to make line drawings that might convey the meaning of various wheeled-vehicle controls. These drawings were subjected to a qualitative analysis to extract common design elements. A preliminary set of 34 symbols, based on the resultant design elements, is presented. Recommendations for further research are included.

TABLE OF CONTENTS

ABSTRACT	111
INTRODUCTION	1
Background	1
I. GENERAL METHOD	5
II. INVESTIGATION OF POPULATION STEREOTYPES	10
Introduction	10
Method	10
Subjects	10
Apparatus	11
Procedure	11
Results	11
DISCUSSION	18
SUMMARY	19
RECOMMENDATIONS	20
REFERENCES	21
APPENDICES	
A. I. Verbal Introduction to Vehicle Symbolology Questionnaire	
II. Vehicle Symbolology Questionnaire	25
B. Vehicle Symbolology Questionnaire Responses	33
C. First-Order Qualitative Analysis (By Control) of Vehicle	
Symbolology Questionnaire Responses	69
FIGURES	
1. Shape Coding of Functional Control Families	9
2. Final Symbol Designs Based on Empirically Derived Symbol Elements	
Arranged by Function and Control Families	16

DESIGN OF A PICTURE LANGUAGE TO IDENTIFY VEHICLE CONTROLS

I. GENERAL METHOD - II. INVESTIGATION OF POPULATION STEREOTYPES

INTRODUCTION

Background

Standardization of military equipment throughout the United States Armed Forces, as well as Allied armed forces such as NATO, has been a continuing problem. It is generally held that logistical problems, as well as training problems, would be greatly simplified if equipment and its component parts were internationally standardized.

One aspect of the standardization of equipment that has been considered is the use of a comprehensive set of labels for equipment controls. The use of a written language to identify a control presents many problems if the user population consists of more than one language group. When considering a population as diversified as the NATO Armed Forces, it might be necessary to use as many as seven languages to identify controls and control functions. One possible answer to this problem is the use of a picture-language, or a set of picture-symbols, to designate controls on various types of equipment. Ideally, these symbols would be cross-cultural, i.e., common to the background of all the specific language or culture groups in NATO.

There are a number of points of view concerning the use of picture-symbols with equipment controls. One basic difference in viewpoint involves the question of whether picture-symbols should merely supplement written language identification of controls, or whether they should replace written language labels. Other considerations are also involved in the practical applicability of a set of picture-symbols. Therefore, at this point it might be useful to discuss the over-all negative and positive aspects of a picture language or "symbolology" with respect to military equipment.

The following arguments against a pictorial symbolology are based on both practical and theoretical considerations:

a. If picture symbols alone are not adequate for replacing written language labels in the identification of controls and indicators, the inclusion of both symbols and labels in a display would present three problems:

(1) Space availability for both symbols and labels on the display surface.

(2) Increasing display complexity decreases the efficiency of the display (6).

(3) Motivation for the learning of the new symbology would be weakened by the presence of already-familiar written labels. The literature on incidental learning and latent learning does not indicate that learning occurs in the absence of motivation (?).

b. The utility of a symbology for identification of controls and indicators decreases as an over-all program of equipment standardization progresses.

Specific standardization trends which decrease the necessity for a symbology include standardization of control and display components, of control arrangements, and of manufacturing and operational procedures.

c. Potential use of proposed symbols:

(1) Training Considerations - In the operation of most types of equipment, the extent to which operators and maintenance personnel rely on labels varies inversely with the competence of the personnel. It should be recognized that reliance on a symbology can in no way substitute for training, although an adequate symbology can facilitate training by reducing learning time.

(2) Illumination Conditions - A set of visual symbols suffers from the fact that it would be of marginal utility in low-illumination conditions.

d. The existence of currently operational written labels - Since several labeling symbologies (languages) are already in use, it is possible that one of those could be adopted as standard labeling. Such adoption would overcome the several disadvantages of a dual symbology suggested in (a) above, and would not contribute further to those disadvantages referred to in (b) and (c) above.

Although the positive arguments for a common military symbology have not been formally documented, the following two points indicate the desirability of such a symbology:

a. A common set of symbols would permit operators and maintenance personnel to perform their mission regardless of the variations of design within particular types of equipment.

b. A set of self-explanatory picture-symbols would reduce personnel training time when individuals are transferred to different types of equipment.

The two positive arguments seem to justify the development of a symbology for military equipment controls and instruments. The negative arguments presented earlier are of value in that they serve as conditions to be taken into consideration in the development of such a symbology.

The ideal solution to the problem of communicating control designations to a multilingual user population would be the development of a culture-common symbology. A culture-common symbology may be defined as that set of symbols in which constituent symbols are meaningful to any users from various cultural or linguistic backgrounds. The following discussion is concerned with possible research strategies to be used in the development of such a symbology.

Empirical research in the development of any cross-cultural symbology could take either of two diametrically-opposed directions, depending upon research philosophy. On the one hand, extensive cross-cultural studies could be conducted in order to determine symbol dimensions which have communality of meaning across all the cultures represented by the user population, e.g., NATO members. Such a study would require considerable effort in terms of time, money, and research resources. On the other hand, a "supra-cultural" approach could be used in which the various coding dimensions would be applied in the development of an abstract symbology (geometric forms, colors, etc.) which, theoretically, would be free of particular cultural biases. Such an approach would require an extensive search of the literature on visual, tactual, and other modes of perception, as well as considerable investment of resources in the generation and testing of what amounts to a "new linguistic". Such an abstract approach would have the disadvantage that potential display users would be required to learn what amounts to a new language.

Somewhere between the extreme of "culture-common" and "culture-free" symbols lies a third possible research strategy. The rationale of the third approach would be to consider persons associated with the operation and maintenance of various items of equipment as being members of a "sub-culture". Various members of the sub-culture, despite wide cultural differences in past experience, would have been exposed to "equipment culture" in their training and duty assignments. The compromise symbology would attempt to exploit fully the communality of equipment-training experience among users by employing picture-symbols to the greatest possible extent, and by supplementing such a pictorial symbology with abstract coding dimensions (geometric forms, colors, numerals, etc.) where necessary. This third research strategy was adopted in the series of studies to be reported. The research orientation was further differentiated into two major objectives:

a. To devise a general method for the development of sets of picture-symbols for various types of military equipment.

b. To test the feasibility of such a method in the development of a specific set of picture-symbols for controls on wheeled vehicles.

I. GENERAL METHOD

This section is concerned with the method to be followed in the development of any set of picture-symbols, as well as certain a priori steps taken in the application of the method to a specific case (wheeled vehicles).

Display problems involve three aspects, therefore a three-step solution is required: (1) definition of the information population; (2) definition of the stimulus population; and (3) fitting the two into a specific symbolic display system. An elaboration of these steps is given below:

Step 1. Definition of the Information Population

An information population consists of all data elements which must be meaningfully presented to an operator working with a particular display. Meaningful presentation in this context means that the symbols in the display can be interpreted correctly by users.

Defining a total information population required finding the minimal number of physical attributes which would describe all information elements in that population. In the specific case of wheeled vehicles, the information population would consist of all those indicators and controls which are found in wheeled-vehicle equipment.

Step 1 would involve two phases of investigation:

(a) Survey of the information population - Data concerning the description, nomenclature, and arrangement of the various control displays found in wheeled vehicles would be collected. This information may be obtained from operator and maintenance manuals for the various vehicles, photographs of the vehicle cabs, and by inspection of the cabs by the research unit.

In the specific case of wheeled vehicles on which the method for developing picture-symbols was tested, the definition of the information population (controls on wheeled vehicles to be encoded pictorially) was accepted as given, except for the determination of the dimensionality of the control population. A set of 34 wheeled-vehicle controls which were currently under consideration by a military user agency (NATO Forces) was taken as the defined population of controls to be symbolized (Step 1(a) above).

(b) Determination of the dimensionality of the information population - Analysis of the total information population to determine the minimal number of defining attributes required to describe any element of information in that population. Two phases of classification of the control population are required at this point.

The first phase involves the classification of information elements by experts in operation and maintenance to determine

which elements are so critical that they should be coded symbolically. That is, which elements are not self-explanatory and, if not, which are of such importance in operations and maintenance that they merit symbolic representation on the instrument panel of the vehicle.

The second phase requires the classification of critical information elements into functional categories. Such classification would be accomplished by experts in the particular field from which the equipment was drawn. An example of such functional classification in the case of wheeled vehicles would be the categorization of the various controls into families of controls such as those concerned with lighting, fuel, etc.

The 34 controls (listed below) currently under study by a military user agency (NATO) were accepted as being critical by the present investigators. It remained only to classify those critical controls by function in order to complete the definition of the information population. To accomplish that classification, each of the given 34 controls was assigned to one of six functional categories as follows:

LIGHTS

1. Main Light Switch
2. Instrument Panel Light
3. Interior Lighting
4. Low Beam
5. High Beam
6. Fog Light
7. Parking Light & Clearance Light
8. Blackout Headlight
9. Blackout Clearance Light

IGNITION

1. Ignition Switch
2. Starter
3. Spark Advance
4. Battery Slave

FUEL

1. Fuel Tank Selector Switch
2. Choke
3. Hand Throttle Control
4. Primer Pump

GEAR TRAIN

1. Front Wheel Drive
2. High Ratio Gear
3. Clutch
4. Neutral

SPECIAL PURPOSE EQUIPMENT

1. Power Take-off Engaged
2. Power Take-off Not Engaged
3. Winch
4. Winch Brake

ACCESSORY EQUIPMENT

1. Direction Indicator
2. Horn
3. Snorkel
4. Windshield Wiper
5. Cabin Ventilation
6. Heater Switch
7. Car Heater (regulator)
8. Radio
9. Top/Bottom

Step 2. Definition of the Stimulus Population

The objective of Step 2 would be the determination of the properties or dimensions of the stimulus population that are available for coding this information in a symbolic display. In the development of pictorial displays, it is recommended that possible coding dimensions be given priority of use in the following order: picture-symbols, two- and three-dimensional form and shape coding, others (color, digital, etc.). In the case of wheeled-vehicle controls, empirical data for this step would come from the following sources:

- (a) Existing vehicle symbologies.
- (b) Related symbologies (traffic, cartographic, etc.).
- (c) Experimental evidence concerning the suitability of abstract symbol dimensions for coding the several control categories as determined in Step 1.
- (d) Survey of the potential user population. This survey would essentially constitute a test to find stereotyped pictorial meanings of the various controls in the user population. Such a test for stereotype requires that a sample of the user population design pictorial symbols for the elements (34 controls) of the information population.

The information generated in Step 2 would provide the basis for the design of a tentative set of symbols for the equipment involved; in the case of the test example, symbols for the 34 controls found in wheeled vehicles.

Step 3. Fitting the Information Population to the Symbol Attributes

This step would involve the empirical determination of the utility of a system of symbols applied to a particular information population. A series of three experimental studies may be used to evaluate the utility of any given set of proposed symbols:

- (a) Accuracy of initial identification - The tentative set of symbols for the controls involved would be displayed to a representative sample of the user population, to see how accurately the symbols could be identified and matched with the controls.
- (b) Ease of learning - The amount of training required for users to meet some criterion of learning for the symbols should be determined if the symbols cannot be immediately identified.
- (c) Symbol effectiveness in a simulated task - The extent to which the proposed symbols contribute to the efficiency of operation of a strange piece of equipment should be determined experimentally. This information could be derived by simulating the operating conditions under which the symbols are to be used.

It should be noted that each of the above tests of the utility of a proposed set of picture-symbols would yield information concerning the relative effectiveness of each symbol in a given set. The simulated task further provides a test for the effectiveness of the entire set of symbols. At any point in the evaluation of a proposed symbol set, it would be possible to modify those particular symbols not meeting efficiency requirements.

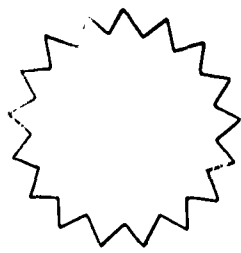
All three evaluative tests in Step 3 will be applied to the control symbols for wheeled vehicles. Those tests will be reported in subsequent Technical Memoranda.

The preceding discussion was meant to provide an over-all introduction to the problem of developing sets of non-verbal symbols for use with various types of military equipment. The method to be used was presented, and Step 1 of that method was applied to the specific case of controls in wheeled vehicles. The application of Step 2 (definition of the stimulus population) to that same set of controls will now be described.

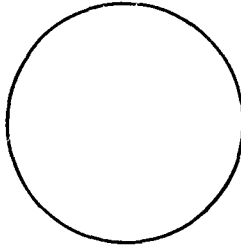
The first requirement of Step 2 is to define the stimulus population. That is, one must find out which dimensions of stimuli, or stimulus attributes, can be used to encode the information about the population of controls. In the case of wheeled vehicles, four sources of information were considered. The first two, existing vehicle symbology and related symbolologies, were found to yield few control symbols. The few available are found on several types of European automobiles (e.g., the Choke and the Hand-throttle control symbols used in the Italian Fiat). The third source of information concerning abstract symbol dimensions was found to provide useful data for encoding the functional families of wheeled-vehicle controls.

Each of the functional categories, or families, of controls was designated by a distinctive shape outline. All shapes had the same maximum dimensions. Fig. 1 shows the functional control families and their shape codes. The coding shapes used were selected for two reasons: existing data about shape discriminability (5); and meaningfulness of shape (for example, a gear shape to designate gear-train family).

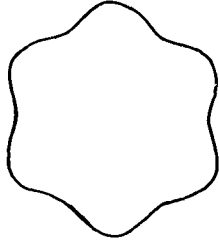
The fourth source of information about the code stimuli was a survey of the potential user population (vehicle operators and vehicle maintenance personnel). Such a survey was conducted; it is described in the following section.



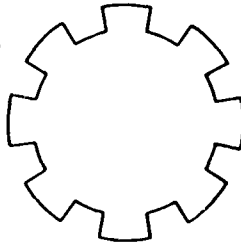
1. Lighting system



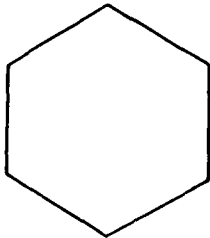
2. Ignition system



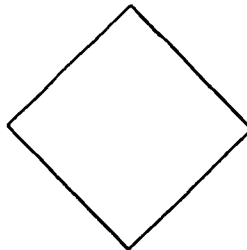
3. Fuel system



4. Power train



5. Special purpose equipment



6. Accessory equipment

Fig. 1. Shape Coding of Functional Control Families

II. INVESTIGATION OF POPULATION STEREOTYPES

INTRODUCTION

The survey of the potential user population followed the general procedure used in testing for response stereotypes in defined populations. The basis for the test-for-stereotype procedure lies in the "unstructured response". Subjects (Ss) are shown a set of stimuli and are permitted to respond freely (within the general response categories that the experimenter has defined). The free-response data are then examined to determine whether or not certain types of responses tend to be elicited "spontaneously". If the data indicate that the stimuli do tend to be associated with certain responses, then these stimuli are said to have population response stereotypes (1). This information is applied by designing "compatible" sets of task stimuli and task responses from a knowledge of population stereotypes.

Although the usual test for population response stereotypes has dealt largely with relatively simple sensory stimuli and responses (2, 3, 4), the procedure has also been used with more complex stimulus and response configurations. A recent human engineering study on the interpretability of road signs (1) used the test procedure for determining population response stereotypes. Subjects were given blank sheets of paper with spaces for six drawings on each page. The meanings of 16 road signs were read aloud, one at a time, at two-minute intervals. Subjects were asked to draw "a sign which they felt would convey the desired meaning and be easily interpreted". Their drawings were then analyzed qualitatively and ten road signs were designed to take advantage of communality of response for particular sign meanings. When these stereotype-based signs were tested further in an identification study with new Ss it was found that they conveyed useful information.

The present study was designed to determine whether or not the test-for-stereotype procedure would provide useful information about basic "picture-elements", and whether this information could be used in the design of picture-symbols for the 34 controls considered in this series of studies.

METHOD

Subjects

A sample of 125 Ss was drawn from a military population. Subjects were students at the U.S. Army Ordnance School, Aberdeen Proving Ground, Maryland. All Ss were enrolled in either an "Automotive Maintenance and Repair" or "Automotive Repair" course. The distribution of the sample by citizenship and rank was as follows:

	<u>Officers</u>	<u>Enlisted Men</u>	
Chile	1	0	
Columbia	1	0	
Denmark	1	0	
France	1	0	
Iran	3	3	
Saudi Arabia	1	0	
Turkey	2	0	
United States	46	56	
Venezuela	4	2	
Viet Nam	<u>0</u>	<u>4</u>	
TOTAL	60	65	N = 125

Because of scheduling difficulties the data were collected in three sessions. Foreign officers and foreign enlisted men were tested at separate sessions; U.S. personnel were tested at a single joint session.

Apparatus

A "Vehicle Symbology Questionnaire" was used (Appendix A).

PROCEDURE

Subjects were assembled and given the questionnaire. An introductory statement of the purpose and importance of the study was made verbally by the Experimenter (Appendix A). The control names and control functions were both presented verbally and written on a blackboard. Control names were presented one at a time. Ss were given one to two minutes for each drawing. Total time required for the 34 control drawings was approximately $1\frac{1}{4}$ hours.

After the three survey sessions had been administered, the squares containing Ss' drawings were cut out of the questionnaire and mounted on large sheets of Manila paper. There were 34 Manila sheets with 125 drawings of a control on each (Appendix B). The data were then analyzed qualitatively at two levels.

RESULTS

The qualitative first-order "factor analysis" consisted of listing all the picture-elements the Ss used to represent a vehicle control. Frequency counts were made of the number of times a picture-element or combination of elements was used for a specific control (Appendix C). For example, Control No. 33 (Power Take-Off Engaged) was represented by a total of eight different

picture-elements: a control device (lever, button, etc.), a gear, winch, or belt drive device, a turning axle, a towing scene (one vehicle pulling another), a "drive-assembly" sketch, and a motor. Of these, the "winch" figure was most popular (30 representations) while "motor" was least frequently used (one representation). Any modification (the use of arrows, cables, etc.) of the basic picture-element was also listed.

The qualitative second-order factor analysis consisted of combining all first-order factors on the basis of communality of picture content. For example, the following second-order factors were derived from the initial classification of the drawings representing the Power Take-Off Engaged control:

- a. Front view of winch with cable shown.
- b. Engaged slip-gear on right side of winch.
- c. Arrows on both winch and drive shaft to show rotation.

The resultant second-order factors, as in the above example, virtually constituted design recommendations for the specific picture-symbols. However, final design recommendations for individual symbols did not depend solely upon the second-order factors but were also subjected to three additional requirements:

- a. The 34 symbols in the final set had to be logically consistent with one another.
- b. Each symbol had to fit into a small area (a circle approximately 1/2 inch in diameter).
- c. The symbols had to be reproducible in raised or embossed designs in plastic.

Each of these restrictions on the application of the empirically-derived symbol factors will be discussed briefly before the results of the second-order factorization and the resultant symbols are presented.

For greatest logical consistency across the total set of 34 symbols, two steps were taken:

- a. Coding of control families - The functional category, or family, to which a given control belonged was indicated by the shape of the symbol outline.
- b. Adherence to symbol type across similar controls - In cases where two or more symbols were related to a common control, variations of the same symbol were used to designate the control functions involved, e.g., Winch and Winch Brake control designations involved the common element of a Winch in the final design of both control symbols.

The area restriction on symbol design was related almost exclusively to the use of fine detail in the symbols. For example, the data indicated that many Ss drew a detailed "illuminated" instrument panel to symbolize the Instrument Panel Light. Since such detail would be lost in the reduction of the symbols to their probable operational size (approximately 1/2 inch), such detail was not included in the proposed design for the Instrument Panel Light symbol.

The conditions that the symbols might, in the future, be presented on the face of plastic control knobs by means of embossed or raised designs led to a number of considerations. One consideration would be the difficulty of tactually perceiving fine detail on a plastic surface. Another consideration would be that embossed reproduction on plastic would restrict the use of figure shading.

With the above qualifications the factors derived from the data were given priority in the design of the proposed symbols. Listed below, in order of test presentation of the controls, are the final elements for each control. The list is followed by a photograph of the symbols designed around those elements.

1. Horn - side view of horn or cone shape, bulb on input; sound waves indicated by straight radial lines; horn bell oriented to the right.

2. Windshield Wiper - front view of one wiper arm with blade, blade emphasized; pivot on bottom of arm; path of blade shown; wiper arm positioned off vertical; pivot well below path of wiper arm.

3. Direction Indicator - two heavy arrows horizontally aligned, arrow heads point away from each other.

4. Radio - front view of rectangular box; two control knobs shown; one rectangular dial face shown; vertical aerial projecting from upper right corner of box, small knob on tip; jagged lines emanating from aerial tip.

5. Heater Switch (On/Off) - schematic of electrical circuit (rectangular) with open switch on bottom line; radiator fins on upper line; vertical wavy lines emanating from fins, emphasis on waviness of lines.

6. Car Heater (Regulator) - same as Heater Switch with following exceptions: emphasis on continuously variable "control" instead of open electrical switch; "regulator" aspect indicated by circular arrow.

7. Cabin Ventilation - 3/4 view of "transom"; air flow indicated by light, curving arrows through transom toward viewer; straight arrow to indicate direction of flow; duct is shown.

8. Ignition Switch - side view of key, teeth down, oriented to the left; electrical switch symbol shown, switch open.

9. Starter - side view of crank with handle and lug head; oriented to the right.

10. Spark Advance - side view of spark plug; lightning bolt shown; distributor concept shown (rotary device); use of rotary arrow.

11. Battery Slave - side view of two batteries with two terminal posts on each, polarities shown; two cables linking plus to plus, minus to minus.

12. Primer Pump - side view of cylindrical pump oriented to the right; straight shaft with plunger and handle; injector nozzle with spray indicated by radiating dashes.

13. Choke - side view of cutaway of tube oriented vertically; constriction near lower end of tube; "butterfly valve" near top end of tube.

14. Hand Throttle Control - side view of cutaway of tube oriented vertically; hand shown pushing or pulling control attached to butterfly valve within tube; valve shown below tube constriction.

15. Fuel Tank Selector Switch - side view of two rectangular tanks; gravity drains shown at inner corner of bottoms of tanks; fuel surfaces within tanks indicated by wavy lines; selector switch shown.

16. Main Light Switch - side view of light bulb, base down; electrical switch symbol shown, switch open; straight lines emanating from bulb.

17. Instrument Panel Light - front view of instrument panel; light source above instruments indicated by "light fixture" (semicircle); radial straight lines emanating from bulb.

18. Interior Lighting - side view of light source attached to an overhead; light source either semicircular fixture, or bulb with base up; radial straight lines emanating down from bulb; light source enclosed in block-type sketch of vehicle.

19. Fog Light - side view of headlamp; diffuse "light field" emanating from lamp face shown by wide angle broken lines or dots.

20. Low Beam - side view of headlamp; "light field" shown with both upper and lower field limit below horizon line.

21. High Beam - same as above with the exception that both upper and lower field limit above horizon line.

22. Parking Lights - side view of two small bulbs, base down; small radial straight lines emanating from each bulb.

23. Blackout Headlight - front view of single lamp, blacked in with exception of slit aperture oriented horizontally with base above median line of circle.

24. Blackout Clearance Lights - same as above with the exception that two small slit apertures are shown, separated on the median line of the circle.

25. Snorkel - side view of straight tube in vertical orientation; 90-degree curve at upper end of tube; tube extended through wavy line.

26. Clutch - side view of two "clutch plates" facing each other, plates not touching, ends of plates angled; arrows showing movement between plates, either one arrow with opposing heads, or two arrows in same plane pointing away from each other.

27. Front Wheel Drive - side view of block-type vehicle, oriented to the right; two wheels shown, rotary arrow around front wheel.

28. High Gear Ratio - side view of two gears, engaged, axes oriented in vertical line; one large gear, one small gear; circular arrow on large gear.

29. Neutral - side view of two gears, disengaged, axes oriented in vertical line.

30. Top/Bottom - Two heavy arrows on vertical line, heads pointing away from each other.

31. Winch - front view of winch oriented horizontally; cable shown.

32. Winch Brake - same as above with the following exceptions: "shoe-type" brake shown; arrow to show direction of force against winch plate.

33. Power Take-Off Engaged - 1/2 front view of winch oriented horizontally; engaged slip gear with shaft shown on right side of winch; cable shown; rotational arrow on both winch and shaft.

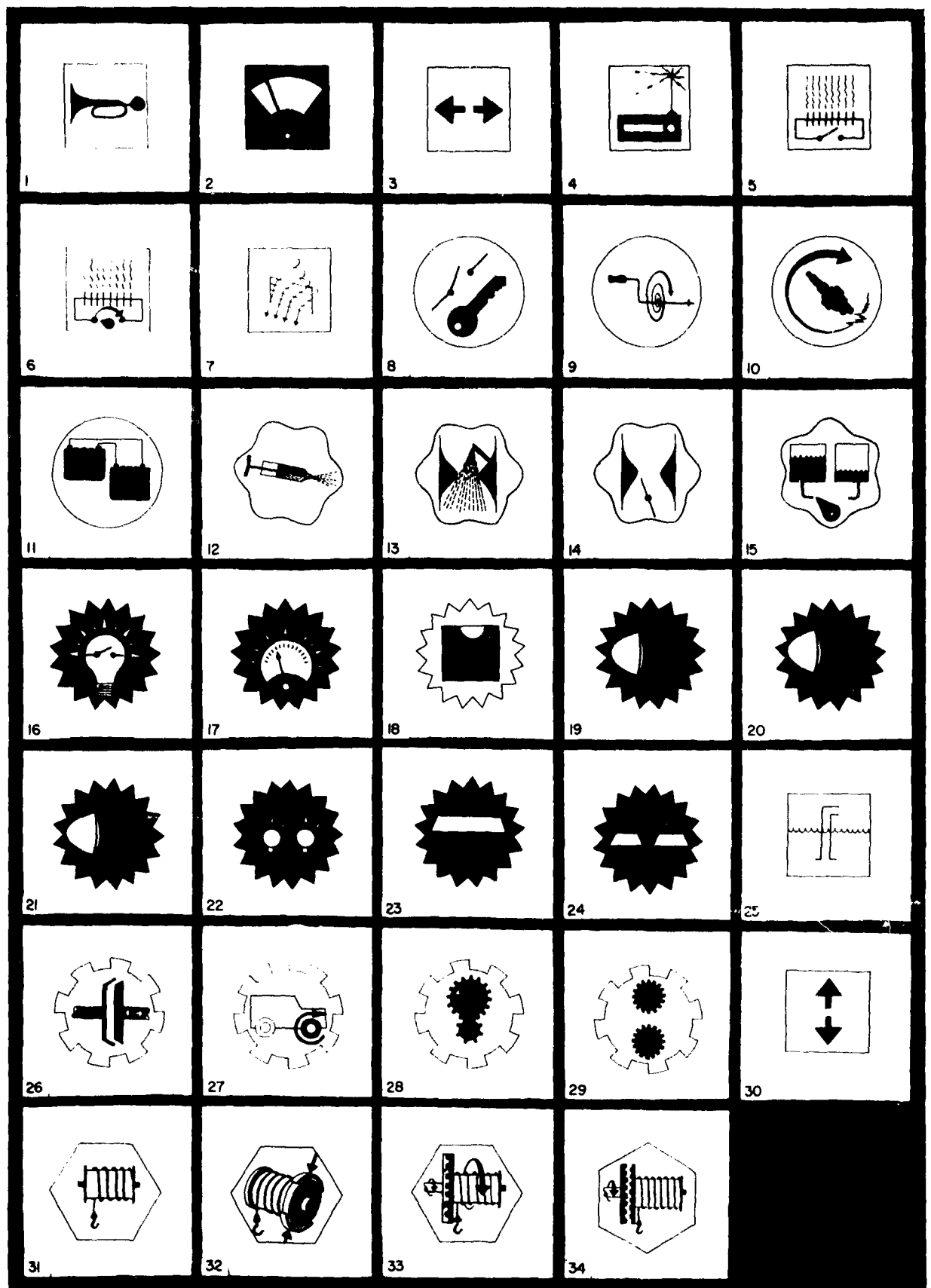
34. Power Take-Off Not Engaged - same as above with the following exceptions: gear disengaged; no arrow on winch.

The prededing list of elements was derived directly from the free-response data. The list provided the empirically derived design elements from which a set of vehicle control symbols was prepared. The reader is reminded that the final design of a given symbol represented a compromise between logical consistency across the total set of symbols, design considerations such as space, surface, etc., and the empirically derived elements. Fig. 2 shows the resultant designs.

LEGEND

Fig. 2. Final Symbol Designs Based on Empirically Derived Symbol Elements
Arranged by Function and Control Families

- | | |
|-------------------------------|--------------------------------|
| 1. Horn | 18. Interior Light |
| 2. Windshield Wiper | 19. Foglight |
| 3. Direction Indicator | 20. Low Beam |
| 4. Radio | 21. High Beam |
| 5. Heater Switch | 22. Parking Light |
| 6. Heater Regulator | 23. Blackout Headlight |
| 7. Cabin Ventilation | 24. Blackout Clearance Light |
| 8. Ignition Switch | 25. Snorkel |
| 9. Starter | 26. Clutch |
| 10. Spark Advance | 27. Front Wheel Drive |
| 11. Battery Slave | 28. High Ratio Gear |
| 12. Primer Pump | 29. Neutral |
| 13. Choke | 30. Up/Down, Top/Bottom |
| 14. Hand Throttle Control | 31. Winch |
| 15. Fuel Tank Selector Switch | 32. Winch Brake |
| 16. Main Light Switch | 33. Power Take-Off Engaged |
| 17. Instrument Panel Light | 34. Power Take-Off Not Engaged |



DISCUSSION

In general the "test for population stereotypes" appears to be applicable in the development of a set of symbols to be used with controls of military wheeled vehicles. In none of the 34 cases did the survey test fail to provide useful information concerning pictorial possibilities for representing controls and/or control functions. In most cases the existence of stereotypes was revealed. However, there were several minor points concerning the mechanics of the procedure which merit discussion as well as some major considerations concerning the general method.

So far as the mechanics of the procedure for testing population stereotypes are concerned, the following guides might be of value in future studies:

- a. Subjects must be reminded to draw their sketches with a heavy hand and to make them as large as the spaces provided allows. (Ss had a tendency to draw lightly and to make small sketches).
- b. Subjects' initial responses should be encouraged, since Ss tend to feel inadequate in their first attempts at drawing. For this purpose the easier controls (e.g., Direction Indicator, Horn, etc.) should be presented first.
- c. The order of stimulus presentation should be arranged so that those controls requiring more than one symbol are adjacent in presentation order (e.g., Heater Switch, Car Heater; Winch, Winch Brake; etc.). Such ordering permits Ss to make their drawings in view of possible distinctions or contrasts between symbols concerning the same control.
- d. Subjects should be instructed that they are not to confer with other Ss concerning the types of drawings that have been made. It should be made clear to the Ss that if they have no immediate response to the control name they should leave the space empty rather than get an idea from another S. When testing for stereotypes an omission is of more use to the experimenter than an "extra" drawing which would tend to give a false impression of the strength of the stereotype.

Among the major considerations in designing tests to find population stereotypes is the problem of representative sampling. The stereotypes must be drawn from a sample which truly represents the population that will eventually use the derived symbols. In addition to this, it is essential to test the meaningfulness of the symbols on a new population sample.

A second consideration is the analysis of the survey data. Due to the nature of the data yielded by the free-response task, it is necessary to rely on qualitative analyses. The qualitative analysis of the symbol sketches requires that several judges spend considerable time inspecting the data in order to identify all possible categories of responses. It is important that all responses be included in one or another category. When such categorization has been accomplished, it is then possible to

rank the frequency of occurrence of various pictorial devices used to represent the control meaning. Once rank ordering has been accomplished, it becomes relatively simple to obtain a composite picture of the over-all data. The next step is to combine the original categories to get higher-order, more general categories, which may be considered as basic factors, or elements, that the Ss used to depict a specific control.

Closely related to the above consideration is the number of omissions obtained for a given response (essentially a no-response category in terms of the above discussion). The range of number of omissions for the 34 controls was 2 - 34. The relatively simple control, "Direction Indicator", yielded 2 omissions; the "Power Take-Off, Not Engaged" and the "Blackout Clearance Lights" yielded 34 omissions each. It is possible that the frequency of omissions is directly related to the strength of the stereotype for a given control. However, this factor may be confounded with others. An omission may not only indicate the relative weakness of a stereotype, but may also indicate that the S had some trouble expressing his "image" of the control by means of a drawing. A more adequate test for stereotype strength would involve a determination of the identifiability of a given symbol on a new sample of Ss from the same population. (Such a test is now in progress at this laboratory. The results of that study will be reported in a later TM).

A final point of discussion involves the actual design of the symbols. The use of empirically derived symbol elements in the design of a specific symbol should not violate the requirement for logical consistency across the entire set of symbols, and should conform to certain design considerations involving the size and surface of the symbol material. In the design phase there is no assurance that a departure from the empirical design elements or their combination will contribute to the increased effectiveness of the symbols. Once again the actual test of the symbols in an identifiability study on a new sample of Ss is the only means by which the designs can be finally evaluated.

SUMMARY

The first section of the report was concerned with a general introduction to the development of picture-symbols for use with various types of military equipment. Negative and positive arguments for such symbolologies were presented. Two alternate research strategies were considered and a compromise approach to the problem was adopted. A three-step procedure for developing a "pictorial symbology" was outlined. The specific case of control symbols for wheeled vehicles was selected upon which to test the method. Step 1 of the method (the definition of the controls to be symbolized), as applied to wheeled vehicles, was accomplished by means of a series of "givens" and a priori decisions.

The second section of the report was concerned with the application of Step 2 of the method, to the population of specific controls (definition of stimulus attributes to be used in the symbols) found in military wheeled

vehicles. A mixed sample of 125 Ss, representing both officers/enlisted men, and foreign/U.S. military personnel attending automotive classes at the U.S. Army Ordnance School, were surveyed in order to determine the existence of response stereotypes for 34 controls found in military wheeled vehicles. Subjects were asked to make line drawings that might convey the meaning of the various controls. The resultant data were subjected to two levels of qualitative analysis by two judges. On the basis of the analyses a number of elements common to the drawings for each control were extracted for use in the design of symbols for the 34 controls. In general, it was found that the procedure used in testing for population stereotypes yielded information useful in the design of symbols for control and/or control functions in military wheeled vehicles. Within the limitations imposed by the necessity for logical consistency and certain design considerations, the empirically derived symbol elements provided the basis for a set of 34 symbols.

A discussion of several methodological considerations was presented, the most important of which was the necessity for testing the designed symbols on a new representative sample of the user population.

RECOMMENDATIONS

On the basis of the above study, the following recommendations are made:

- a. The design of any set of symbols for use on military equipment should be preceded by a test for "response-stereotype" in the user population.
- b. The symbols designed on the basis of this study should be subjected to an identifiability test on a new sample drawn from the same population.
- c. If the symbols developed are to be used by a population other than that of which the test sample was representative, the test for stereotype should be conducted again on the proposed user population.

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6. Loucks, R. B. An experimental evaluation of the interpretability of various types of aircraft attitude indicators. In P.M. Fitts (Ed.) Psychological Research on Equipment Design. Washington, D. C.: U. S. Government Printing Office, 1947.
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APPENDICES

APPENDIX A. I. Verbal Introduction to Vehicle Symbolology Questionnaire

II. Vehicle Symbolology Questionnaire

APPENDIX B. Vehicle Symbolology Questionnaire Responses

APPENDIX C. First-Order Qualitative Analysis (by control) of Vehicle
Symbolology Questionnaire Responses

APPENDIX A

I. VERBAL INTRODUCTION TO VEHICLE SYMBOLOGY QUESTIONNAIRE

II. VEHICLE SYMBOLOGY QUESTIONNAIRE

(Form ORDBG 8176-(0), 10 July 61)
(consisting of 4 pages)

APPENDIX A

I. VERBAL INTRODUCTION TO VEHICLE SYMBOLOGY QUESTIONNAIRE

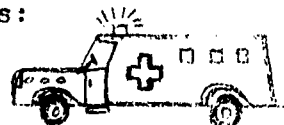
Good afternoon. You gentlemen have been assembled here today because of your present and past experience with military wheeled vehicles. It is our opinion that with your backgrounds you may be able to give us some very important, basic information that is needed in order to solve a rather interesting problem.

This problem is as follows. At the present time our Allied forces overseas are using military vehicles which are manufactured in many different countries. Vehicle control designs and methods of positioning of these controls differ considerably from one nation's vehicle to another. Since military users of all nationalities must be able to effectively utilize these vehicles, the instruction plates and labels for the various vehicle controls are being printed in several different languages. This procedure presents many problems, one of which is space limitations on the control panels or dash-boards.

One answer to this problem is to develop a set of symbols or pictures which could take the place of the worded labels now being used. The pictures would be easily recognizable by all nationalities, regardless of language. They would enable the operators and maintenance personnel of one nation (and language) to work more easily with vehicles which were not manufactured in their own country.

This, then, is what we would like you to do for us. We have a list of 34 controls which are commonly found in military wheeled vehicles. We will give you the name of each of the controls (both orally, and written out on this blackboard), one at a time. For each of the control names we would like you to draw a picture. It should be the first idea that comes to mind when you hear the control name. You will be given about 2 minutes to draw each of the pictures. Please remember, this is NOT a test of your artistic talent or ability! We require only a simple line drawing for each picture. Try to think in terms of basic ideas. For example, if I gave you the word "ambulance" and asked you to represent this by a picture, you might draw something like this:

[on blackboard]



This is definitely NOT the type of drawing we want! [Place large "X" over picture drawn].

We want only the basic idea. What might suffice for the word ambulance is this alone:

[on blackboard]



This particular symbol is internationally used. It may represent any kind of first-aid station. This is the type of thing we are looking for.

Another example may be taken from the international road signs used in Europe. The symbol used to warn the driver of a bumpy road ahead is simply this:

[on blackboard]



[erase blackboard].

I will now give you some of the rules you are to follow.

- a. Do not copy another person's drawing, we want your own ideas.
- b. If you do not know what to draw for any one symbol leave the space blank.
- c. If you are unfamiliar with any control, please raise your hand. An automotive expert will answer your questions.
- d. This is NOT a test of your artistic talent. Please draw simple line pictures.
- e. We do not want pictures of the actual controls. The pictures are to symbolize or represent the control.
- f. Do not include letters or words in your drawings.
- g. Keep the drawing within the square provided.

II. VEHICLE SYMBOLOLOGY QUESTIONNAIRE

This questionnaire is concerned with the use of picture symbols in military equipment. It is primarily concerned with a set of symbols to be used on the control panels of various types of military vehicles. The purpose of such symbols would be to allow vehicle drivers or vehicle maintenance personnel of any nation to more easily identify and use the operating controls in an unfamiliar vehicle.

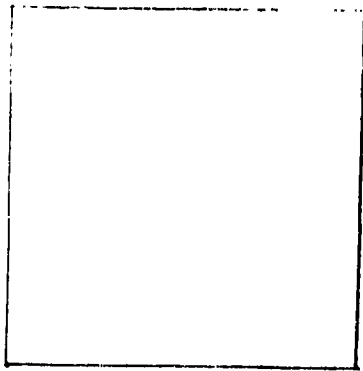
Your opinion and cooperation will be of considerable value in developing such a set of symbols.

Please write in the following information:

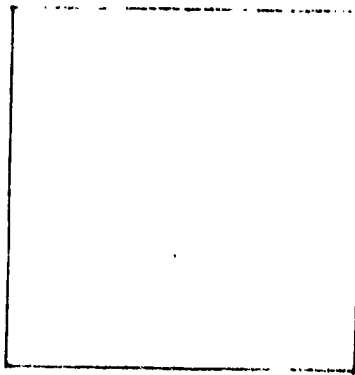
1. NAME _____ 2. RANK _____ 3. SERVICE NO. _____
4. NATIONALITY _____ 5. LENGTH OF TIME IN MILITARY SERVICE _____ YEARS
6. MILITARY JOB _____
7. CIVILIAN OCCUPATION BEFORE JOINING MILITARY SERVICE _____
8. TYPE OF CIVILIAN TRAINING OR EDUCATION _____
9. DO YOU DRIVE A VEHICLE? WHEELED? _____ TRACKED? _____
10. DO YOU DRIVE VEHICLES IN YOUR MILITARY JOB? WHEELED? _____ TRACKED? _____
11. HOW LONG HAVE YOU BEEN WORKING WITH VEHICLES IN THE MILITARY SERVICE?
a. DRIVING _____ yrs. b. MAINTENANCE _____ yrs.
c. OTHER (briefly describe) _____; _____ YEARS
12. HOW OFTEN DO YOU DRIVE MILITARY OR CIVILIAN VEHICLES THAT ARE MANUFACTURED IN COUNTRIES OTHER THAN YOUR OWN? (check one): FREQUENTLY SELDOM NEVER
13. HOW FAMILIAR ARE YOU WITH VEHICLES OTHER THAN THOSE MANUFACTURED IN YOUR OWN COUNTRY? (check where applicable):
a. DRIVING: VERY _____ SOME _____ NOT _____
b. MAINTENANCE: VERY _____ SOME _____ NOT _____
c. OTHER: VERY _____ SOME _____ NOT _____

There are 31 controls commonly found in wheeled vehicles. We would like you to sketch a symbol to represent each control. Each control will be described to you one at a time. First write (in your native language) the name of the control in the space beneath the appropriate space. Then you will have a short period of time to sketch a picture to represent that control. For example, the symbol for aid station, hospital, or ambulance might be a cross (⊕).

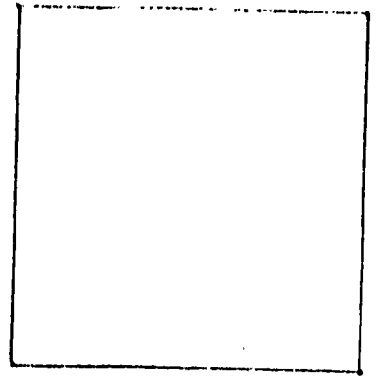
Please keep your pictures within the squares. Do not use words in the pictures.



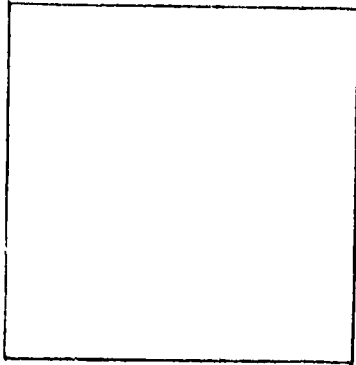
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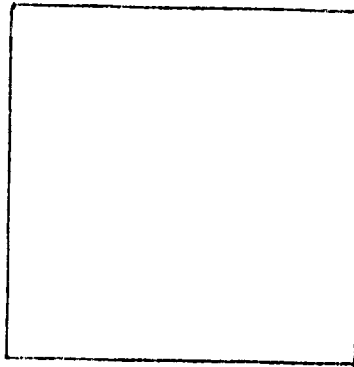
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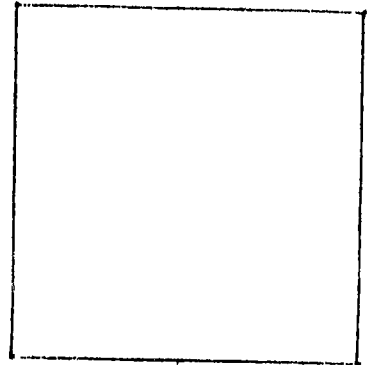
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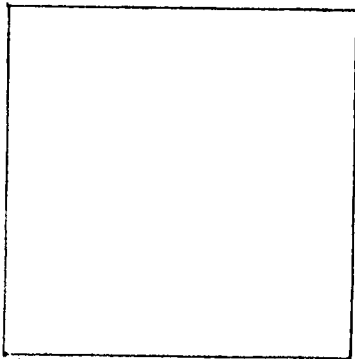
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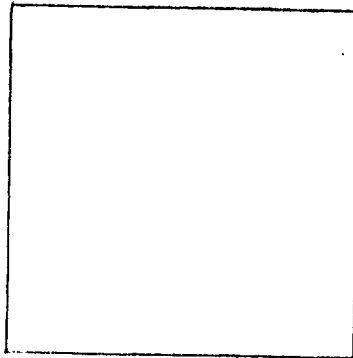
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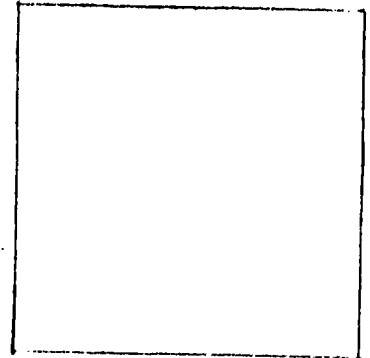
6. _____



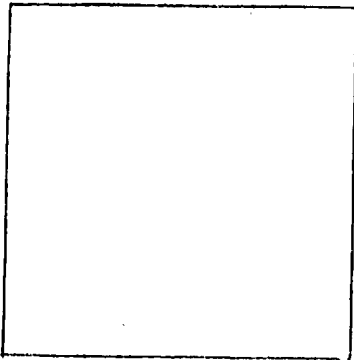
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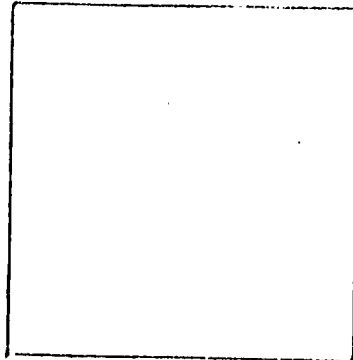
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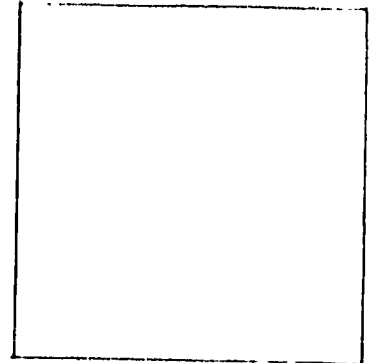
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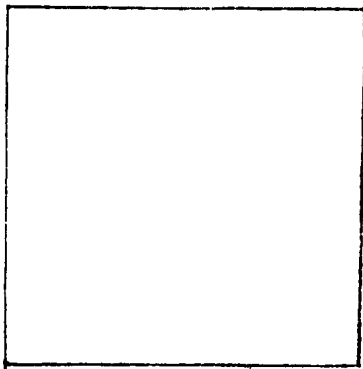
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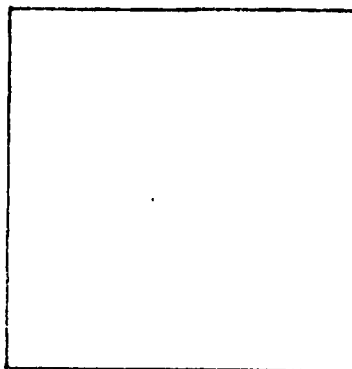
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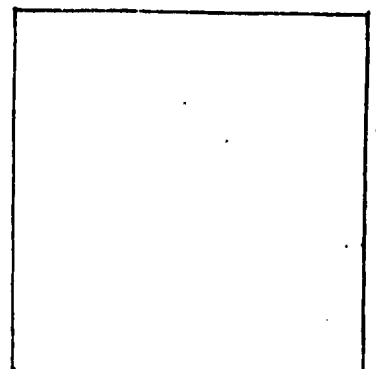
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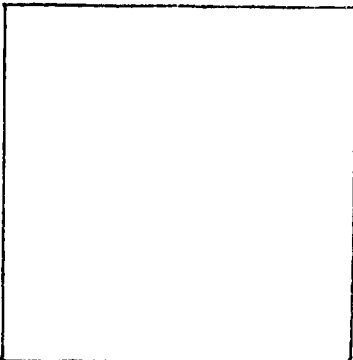
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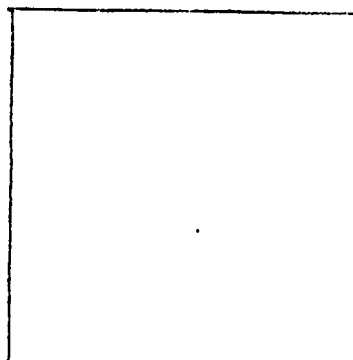
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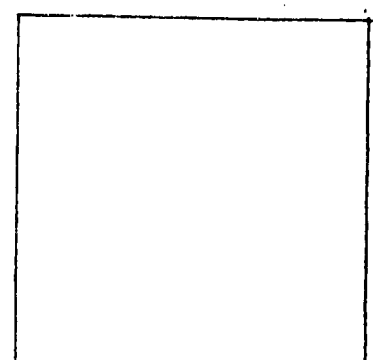
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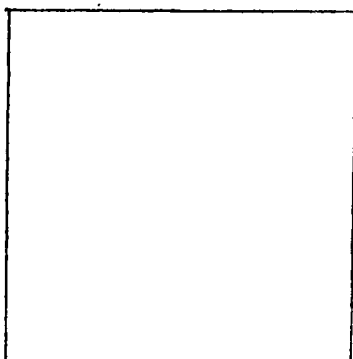
16. _____



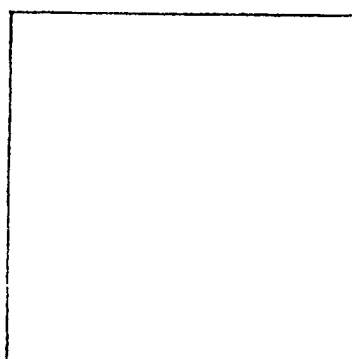
17. _____



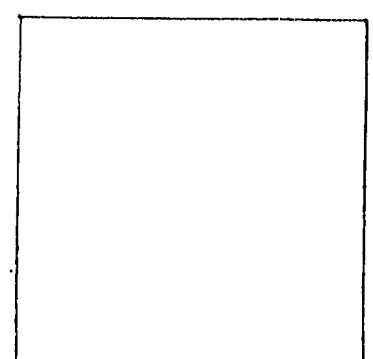
18. _____



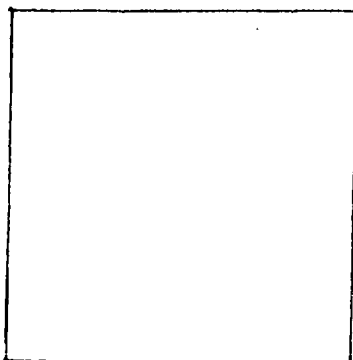
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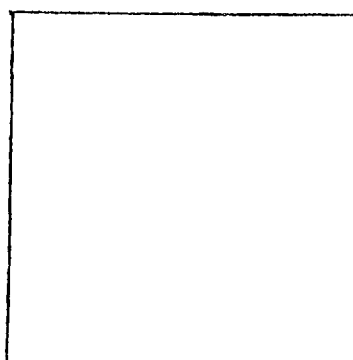
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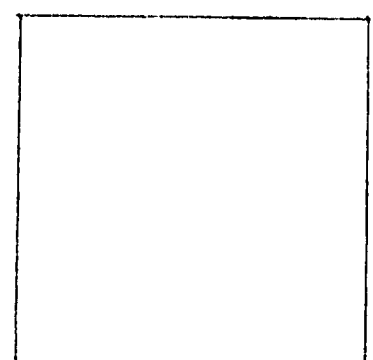
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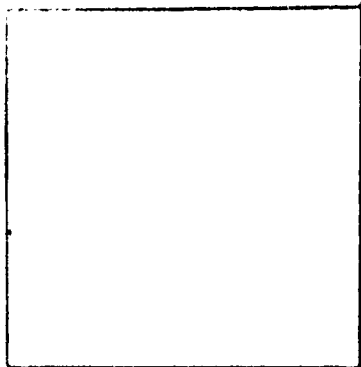
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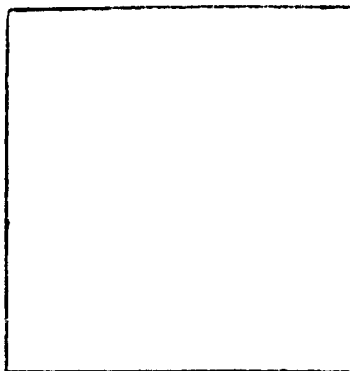
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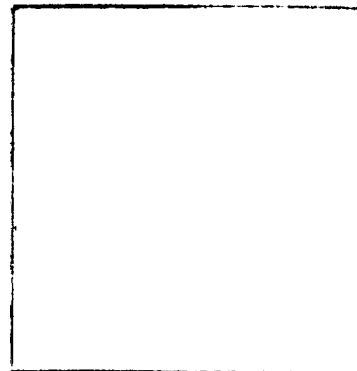
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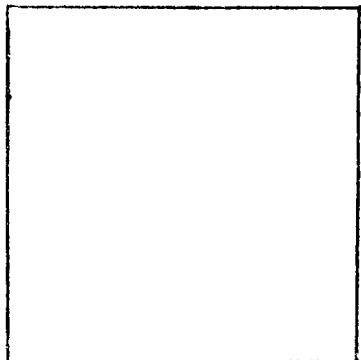
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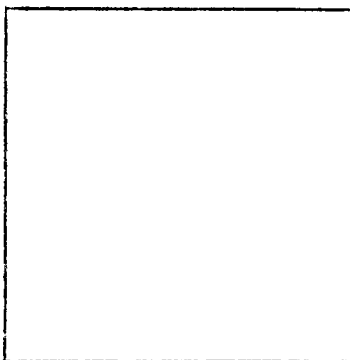
26. _____



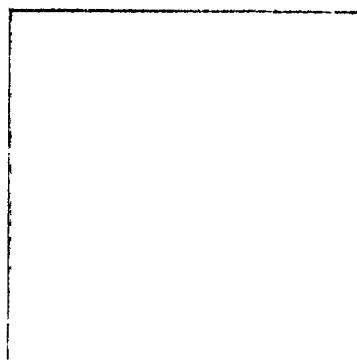
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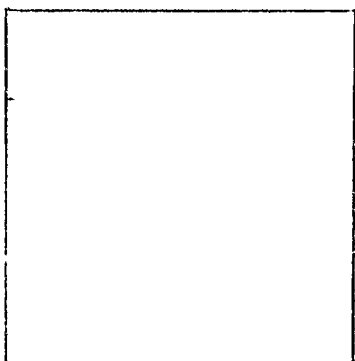
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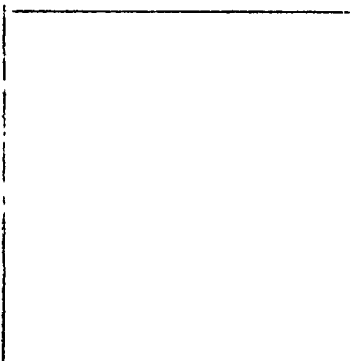
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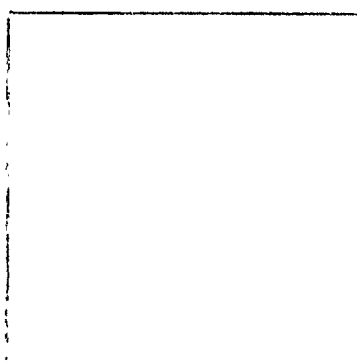
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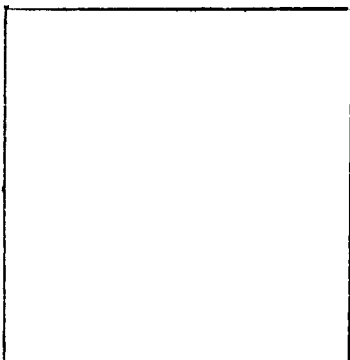
31. _____



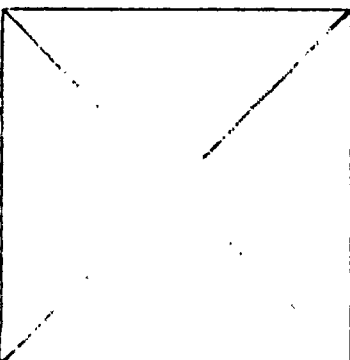
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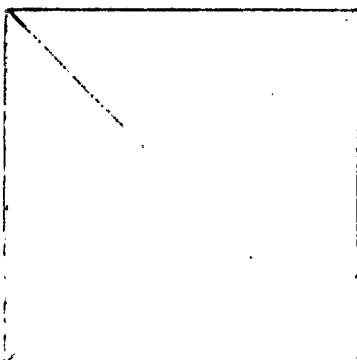
33. _____



34. _____



35. _____



36. _____

APPENDIX B

VEHICLE SYMBOLOGY QUESTIONNAIRE RESPONSES

Following, are photographs of all drawings (responses) obtained (for 125 subjects) for each control name.

The 34 photographs are in order of original presentation of the control names.

The responses (A-1 through H-16) in each photograph are arranged in the following manner:

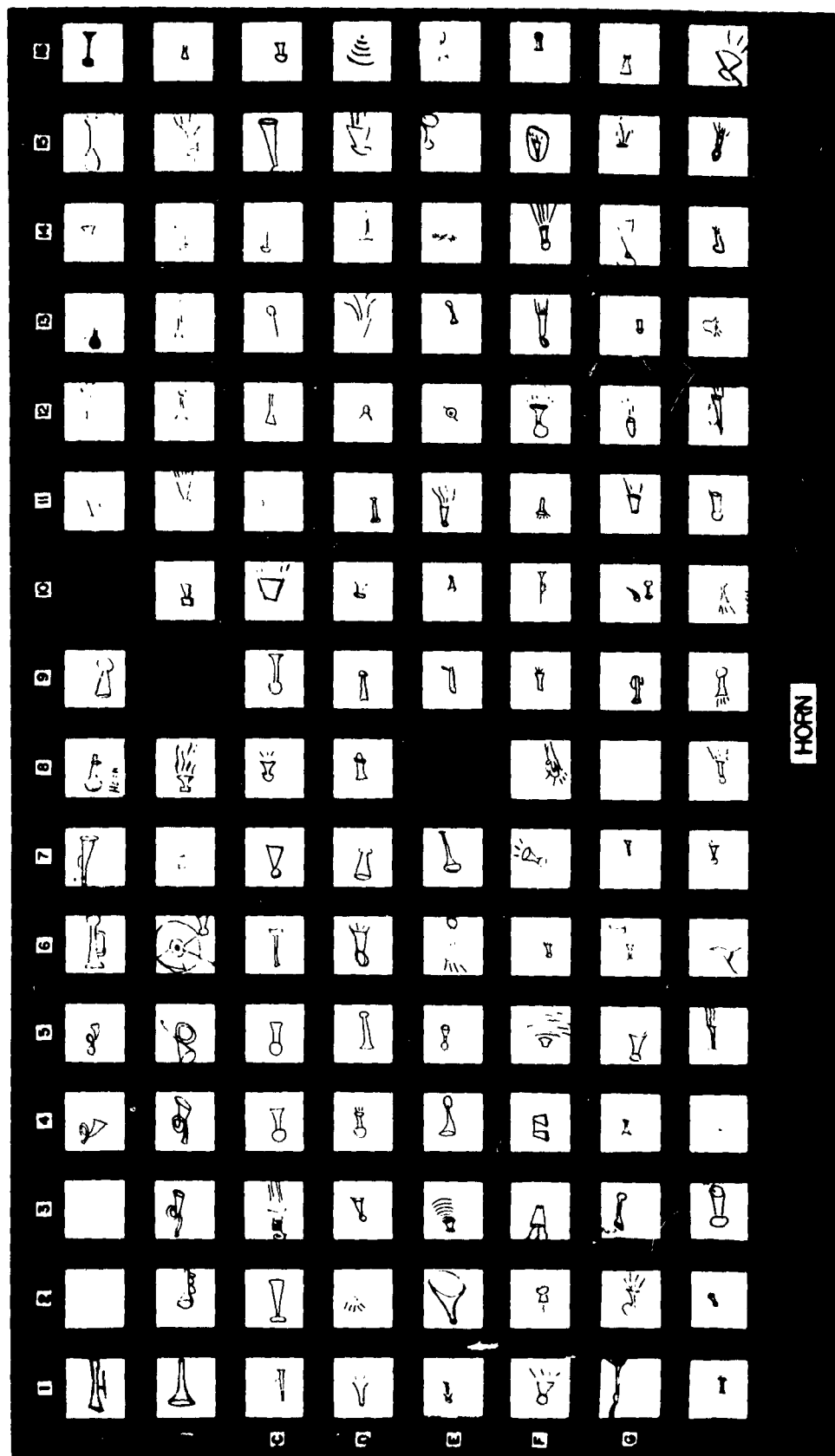
Foreign Enlisted Men..... A-1 through A-9

Foreign Officers..... A-11 through B-8

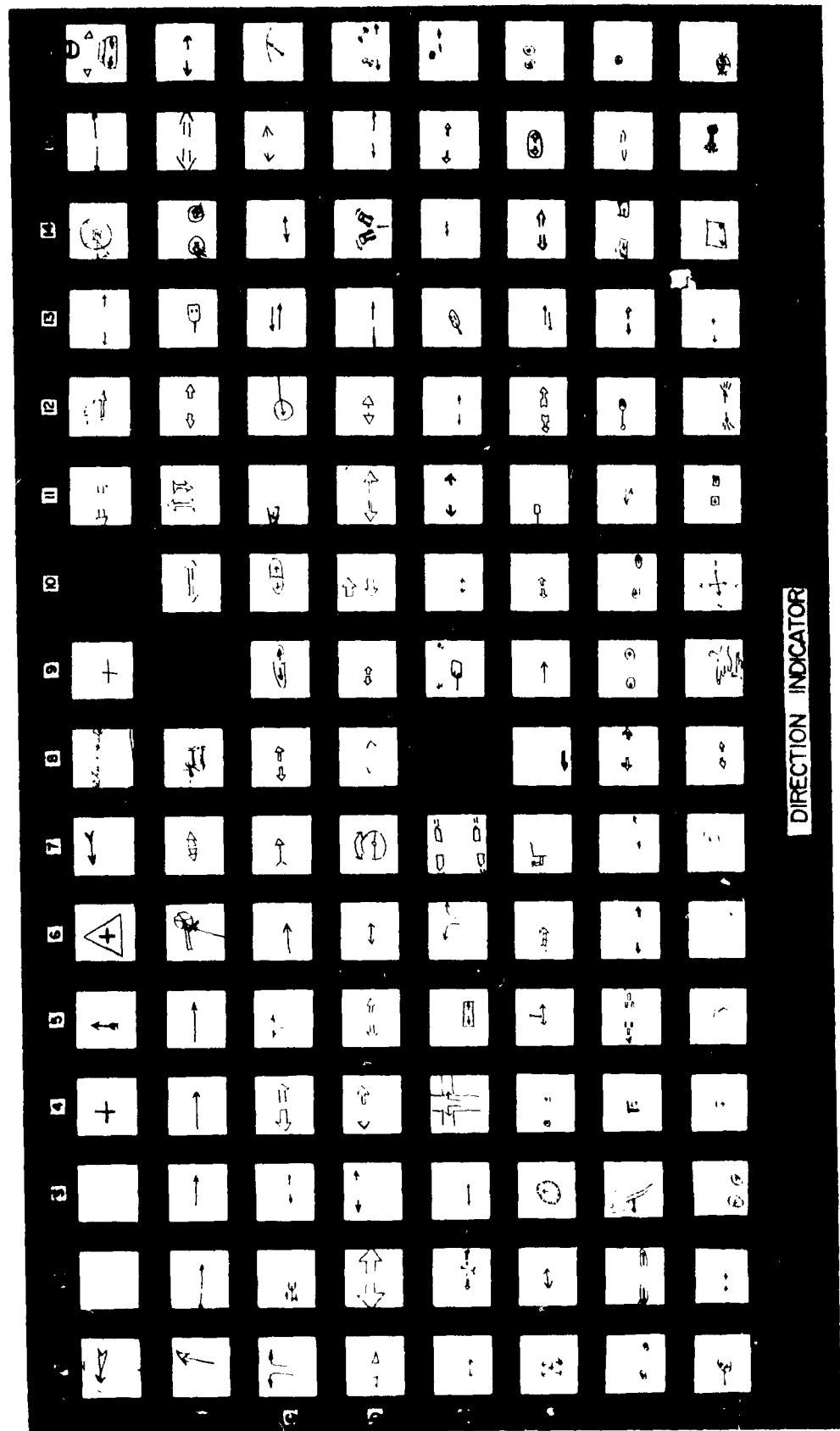
American Officers..... B-10 through E-7

American Enlisted Men..... E-9 through H-16

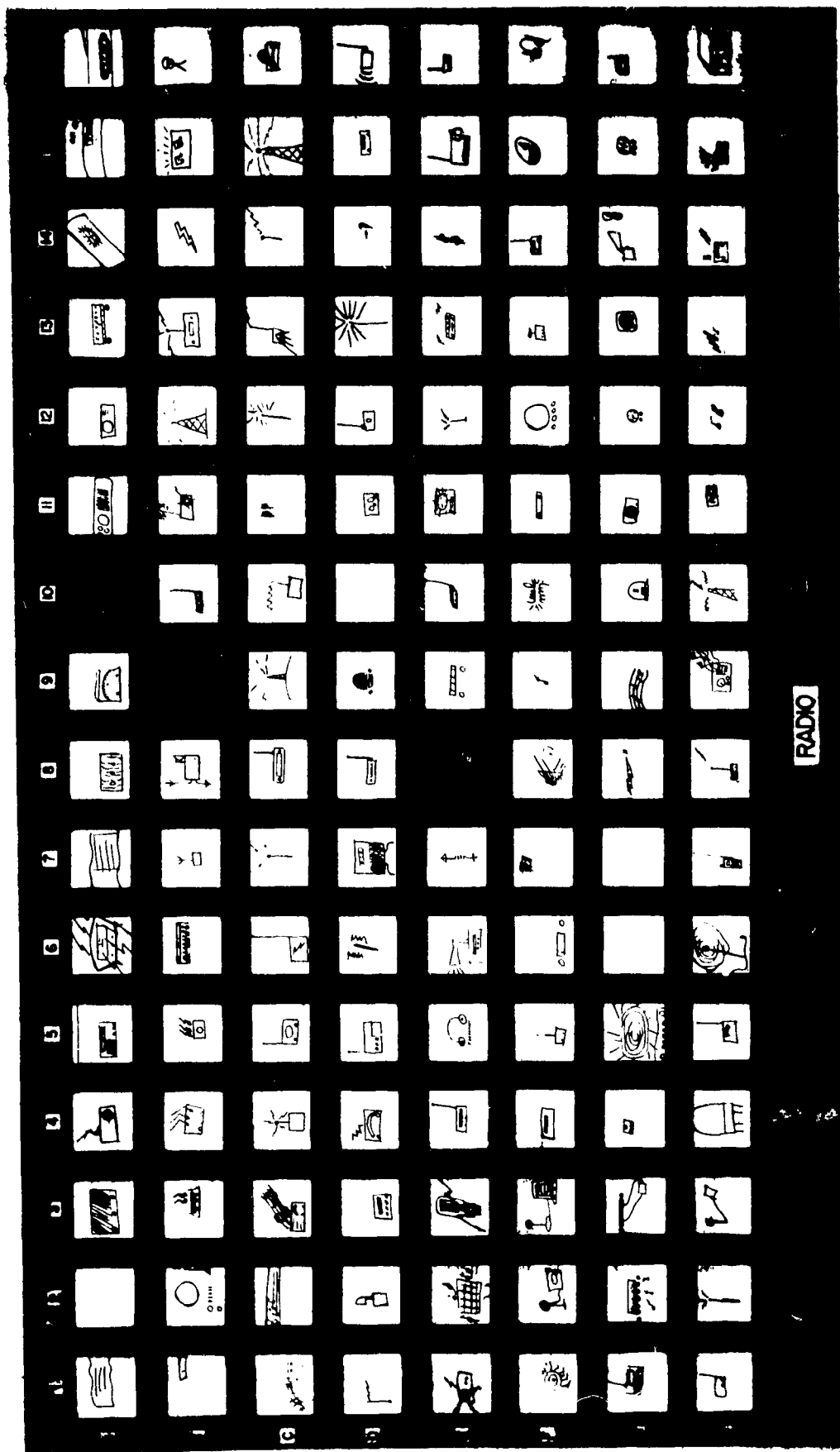
All responses from any one subject will be found in the same position in each photograph, e.g., all drawings in position A-1 were obtained for one S, all in position B-1 from another S, etc.



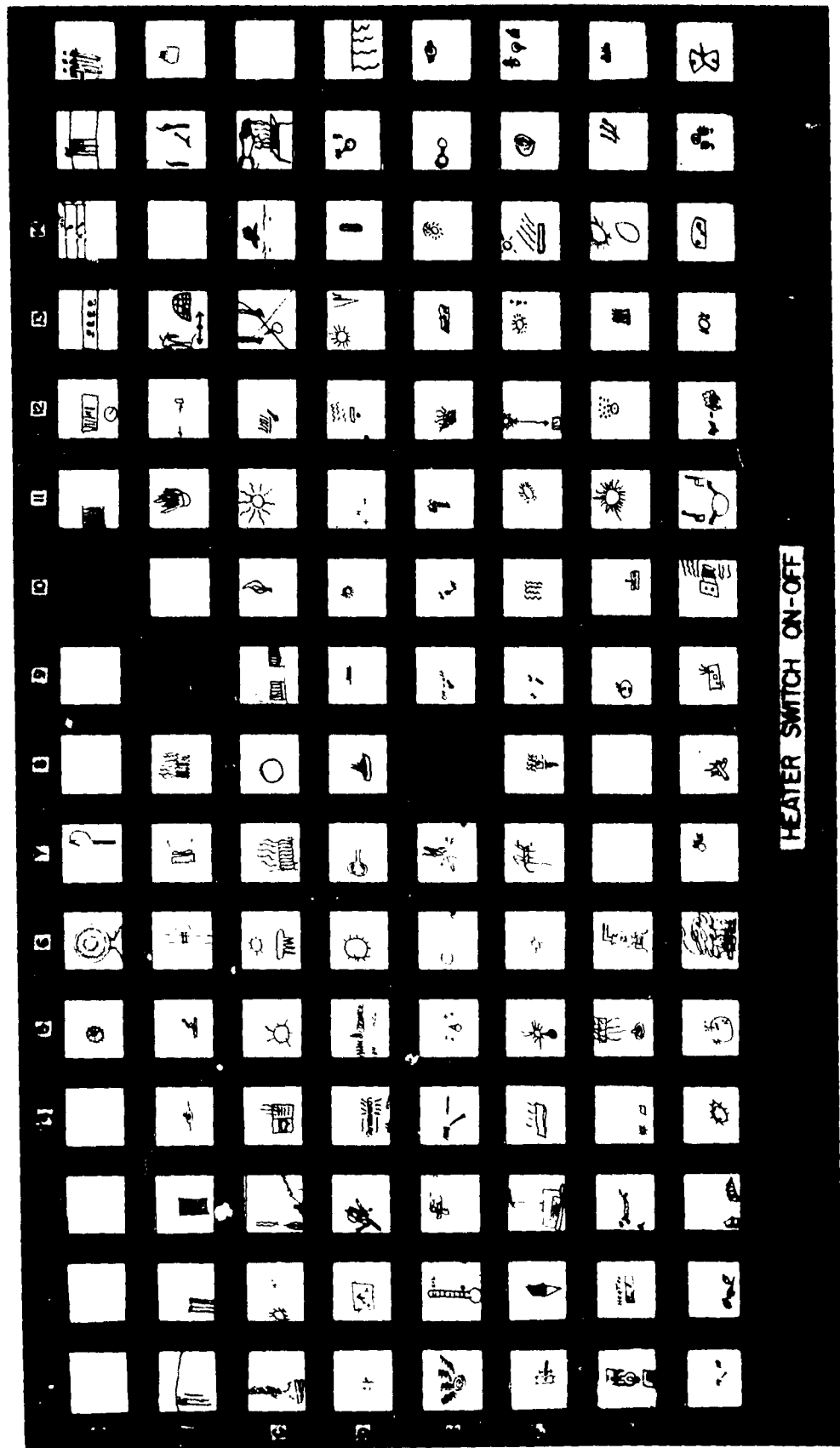
NOH

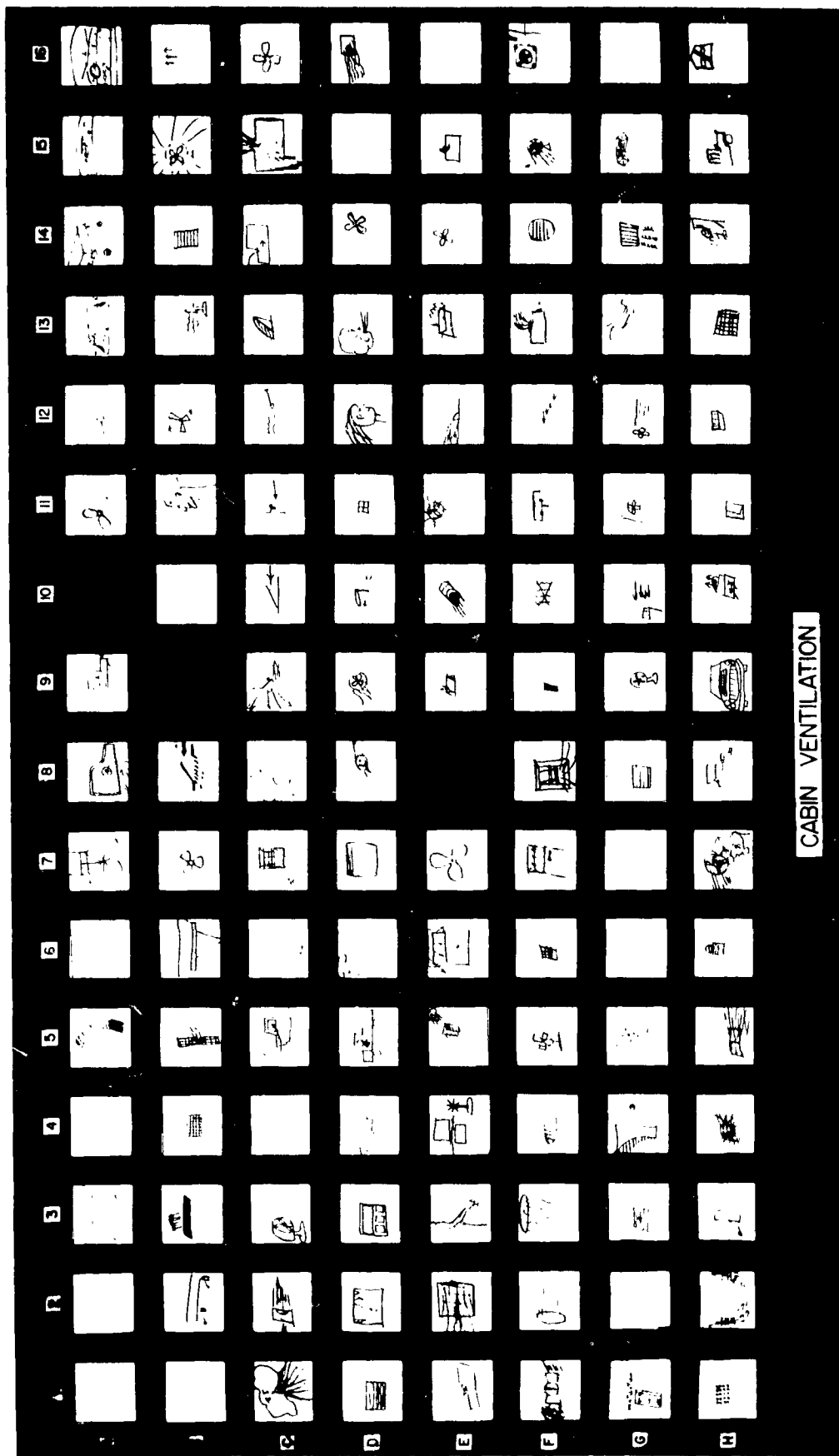


DIRECTION INDICATOR

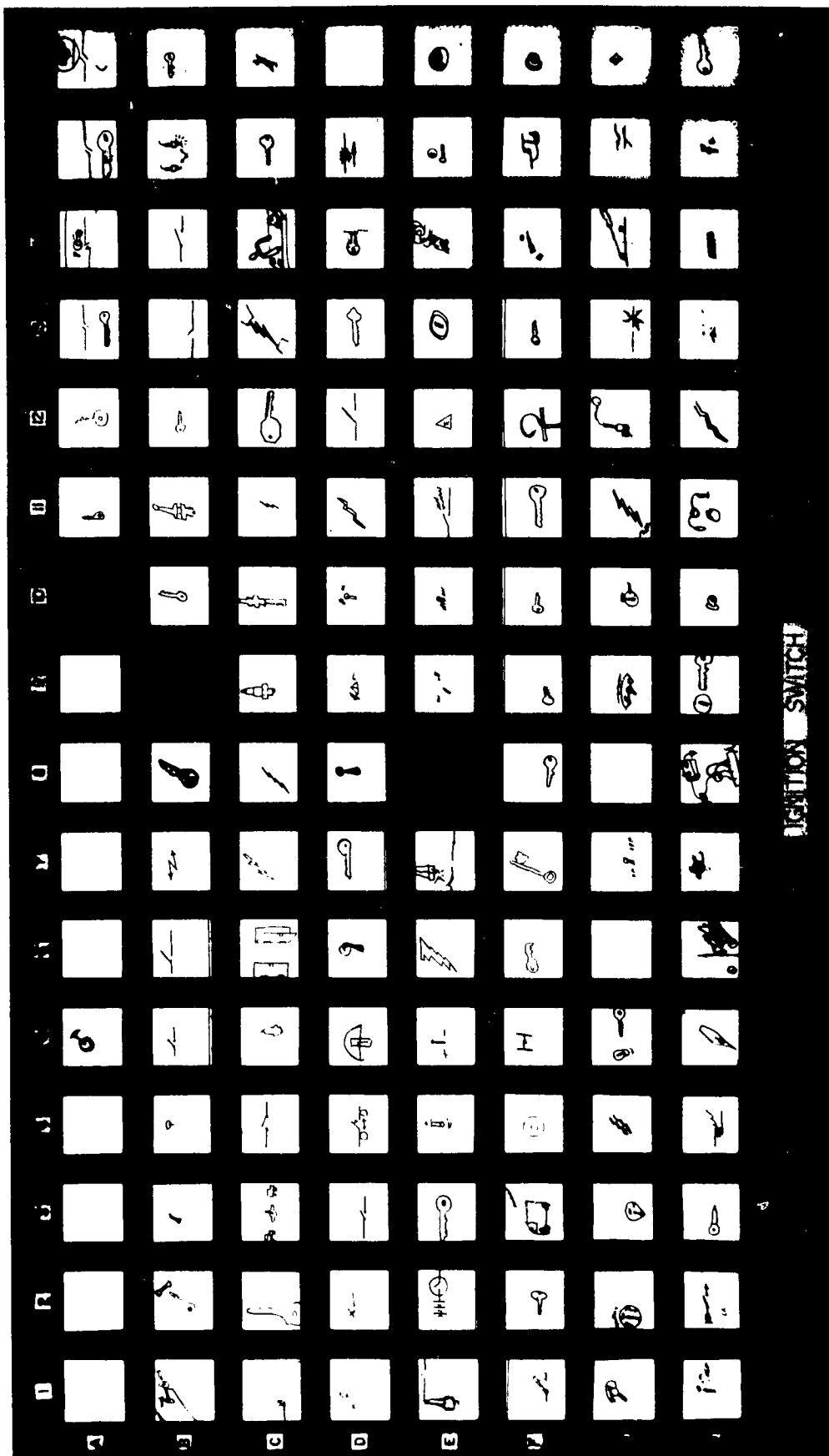


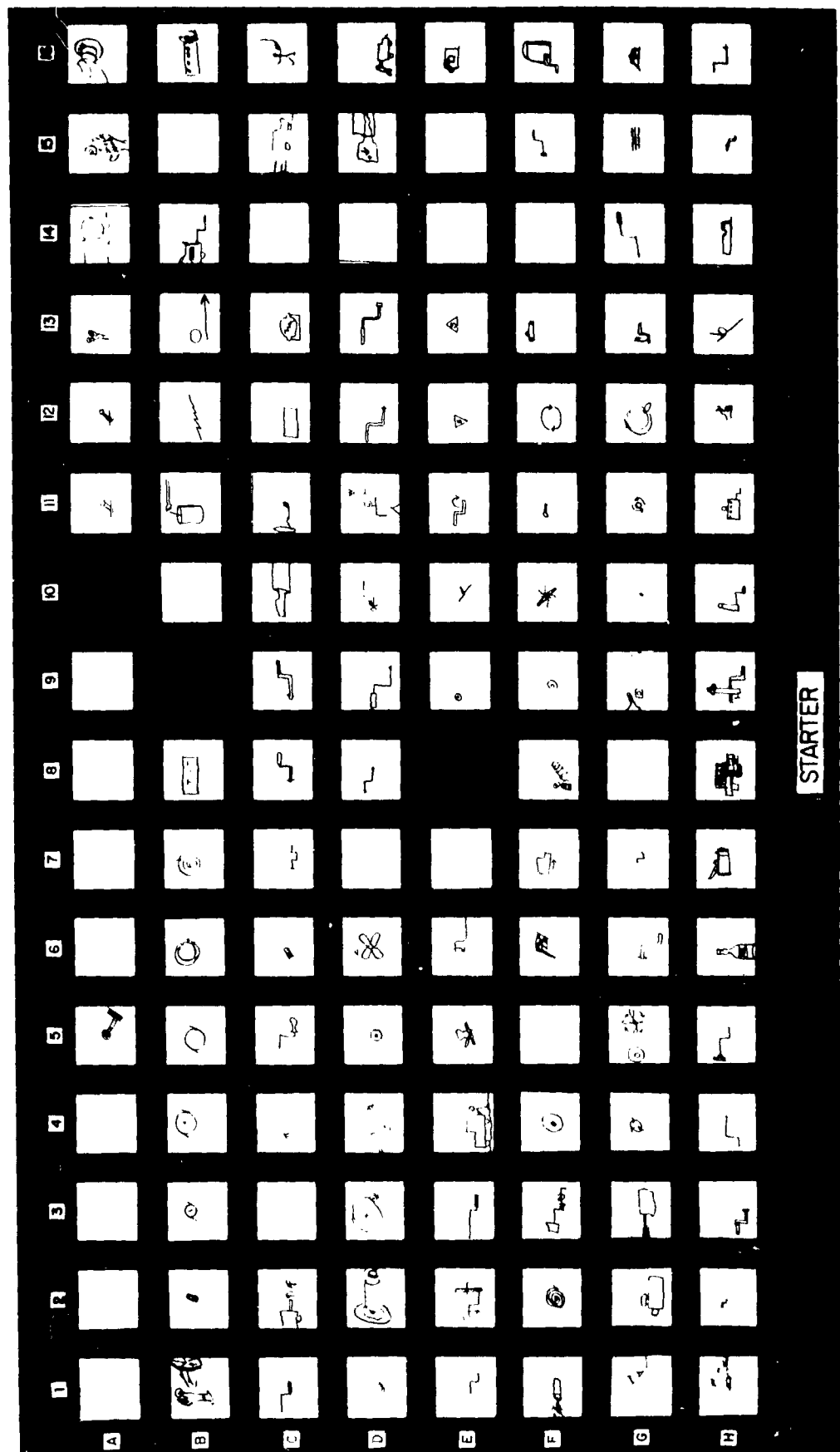
RADIO

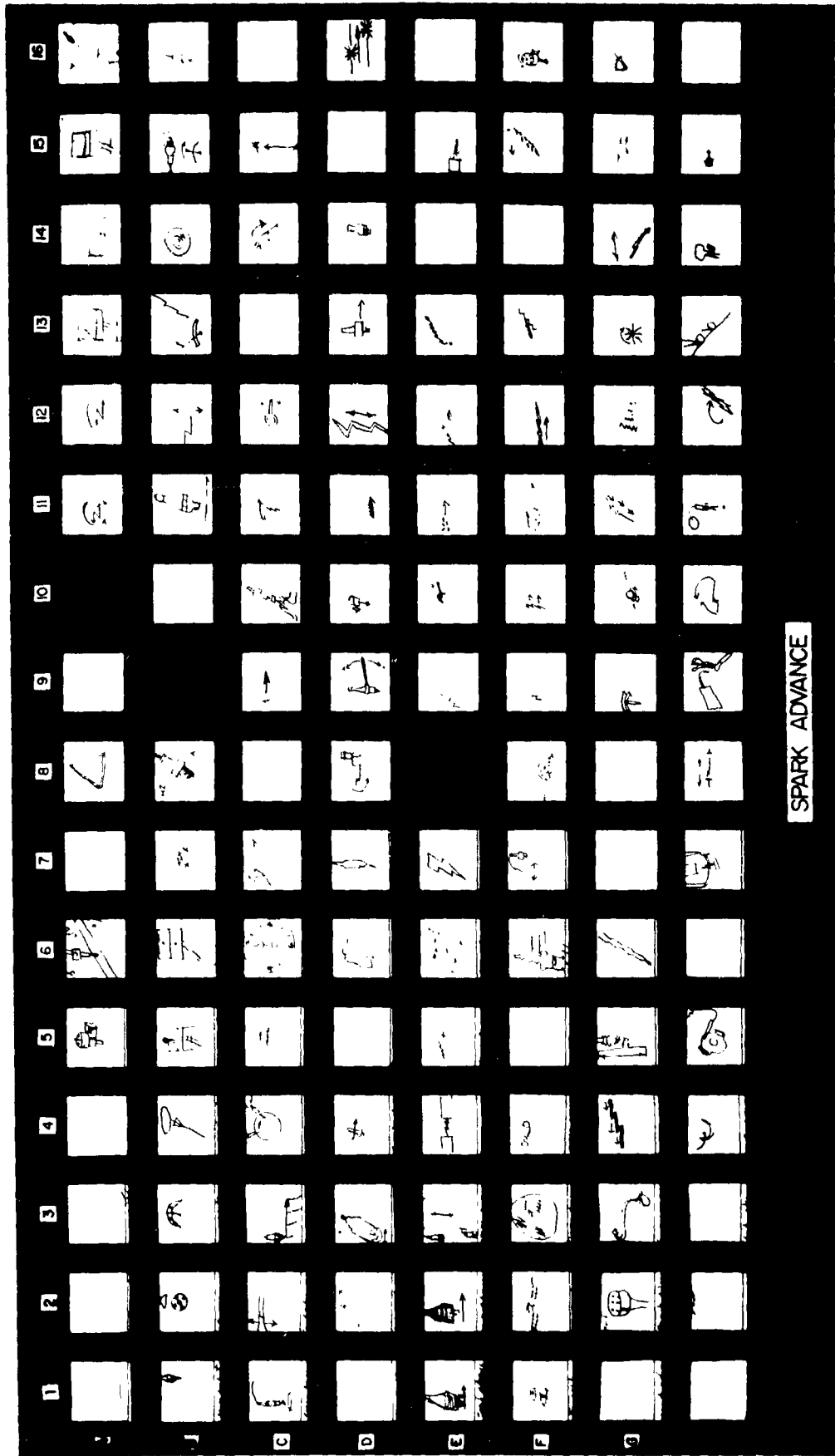




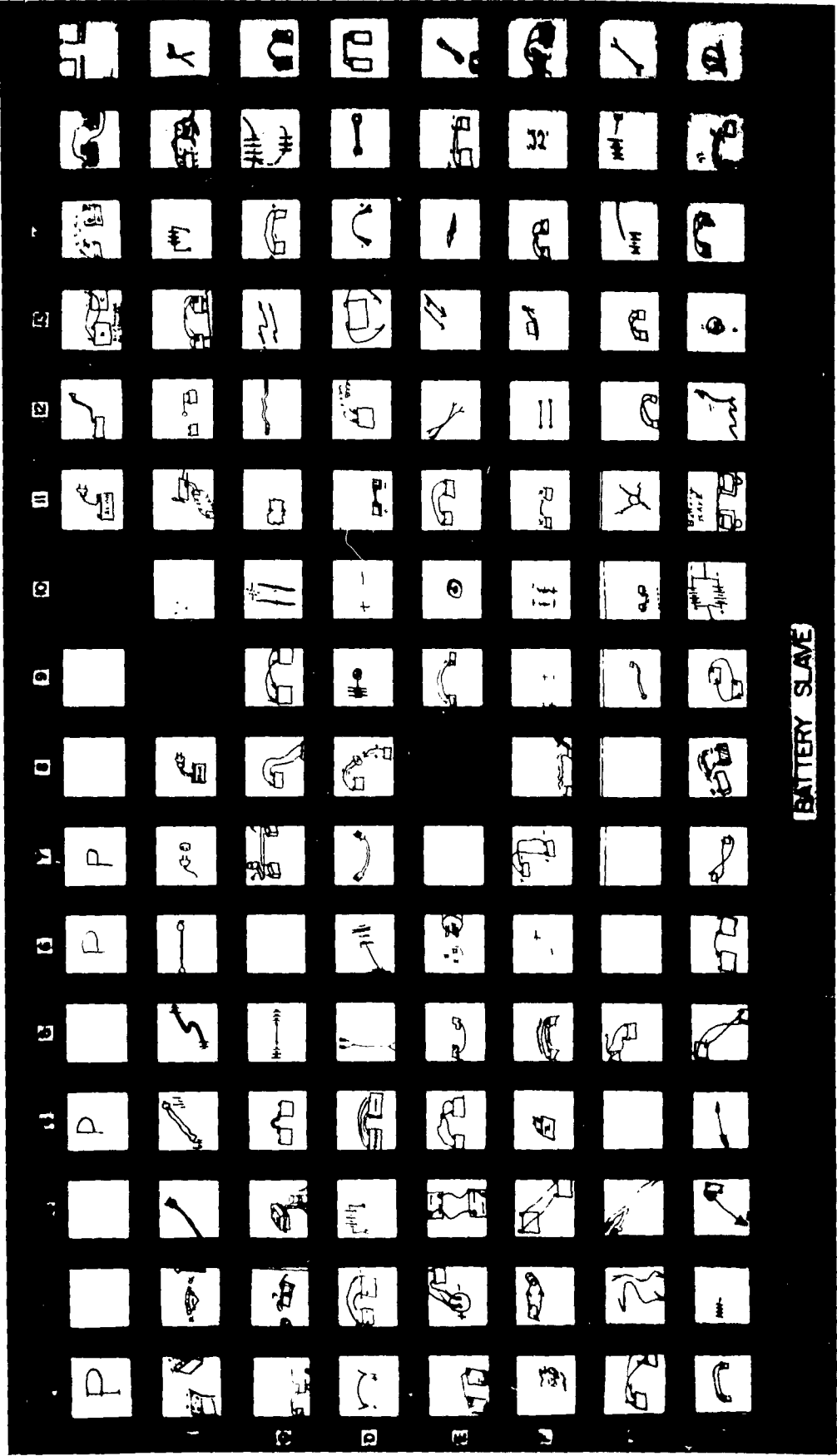
CABIN VENTILATION



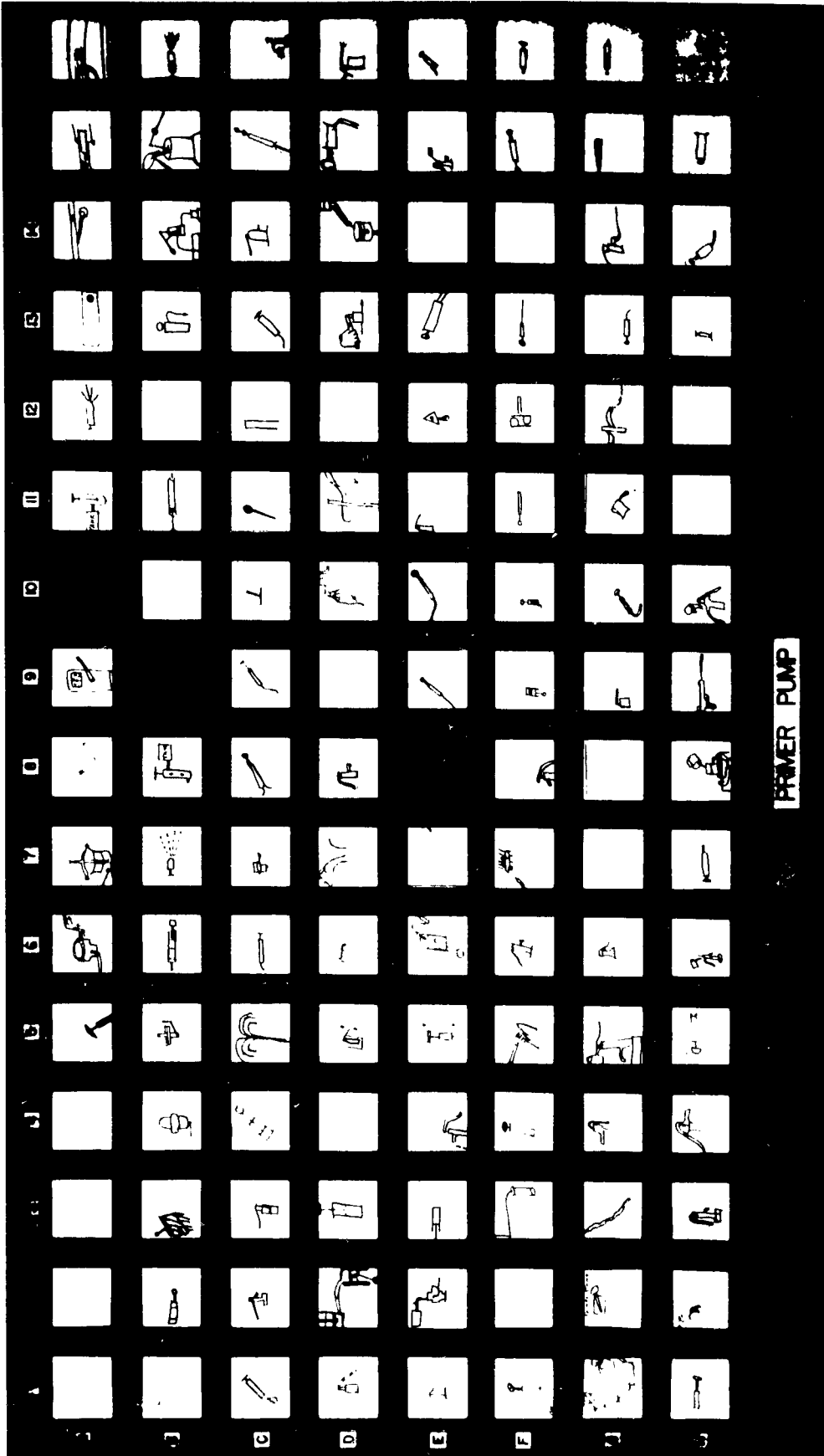




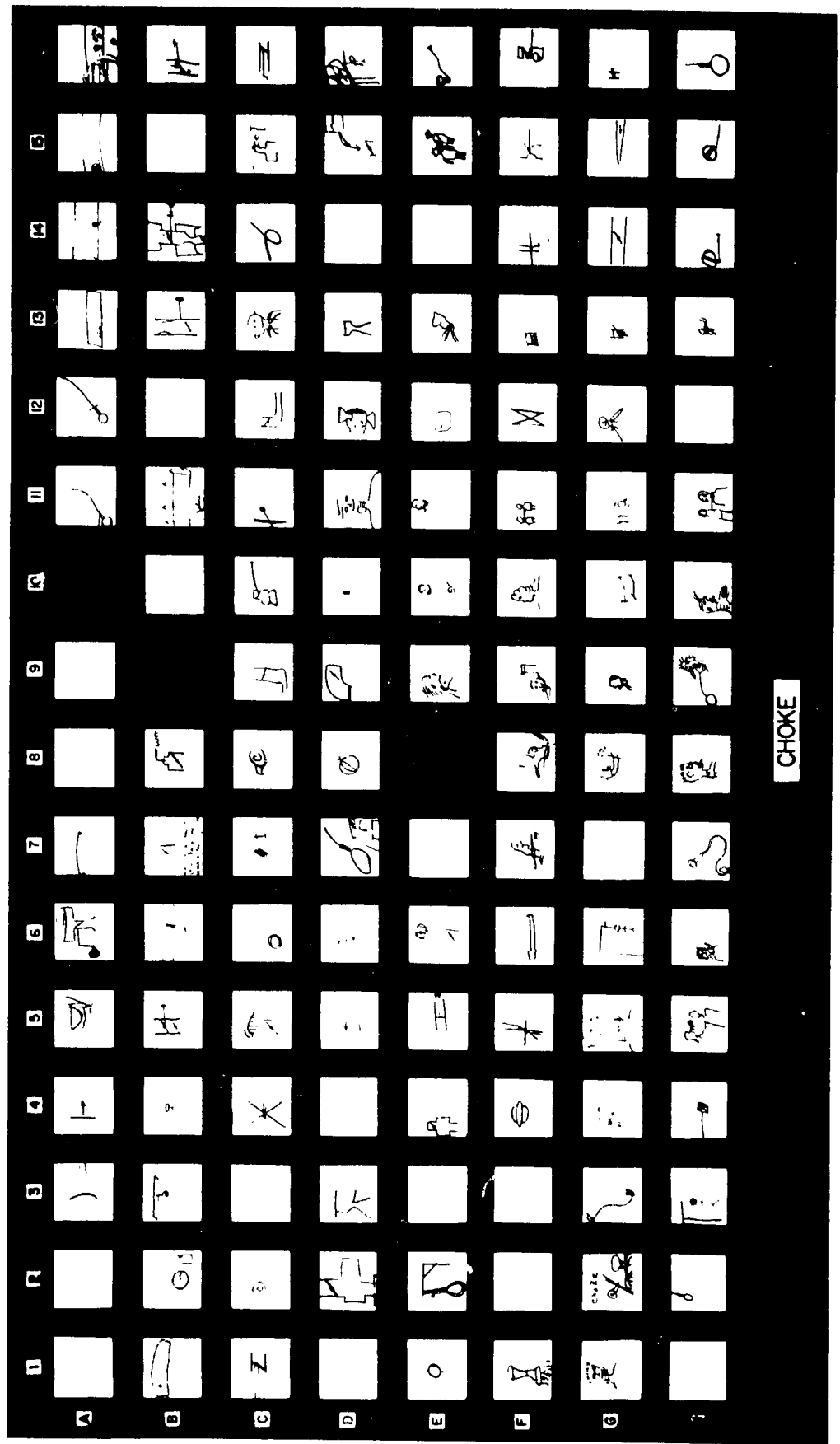
SPARK ADVANCE



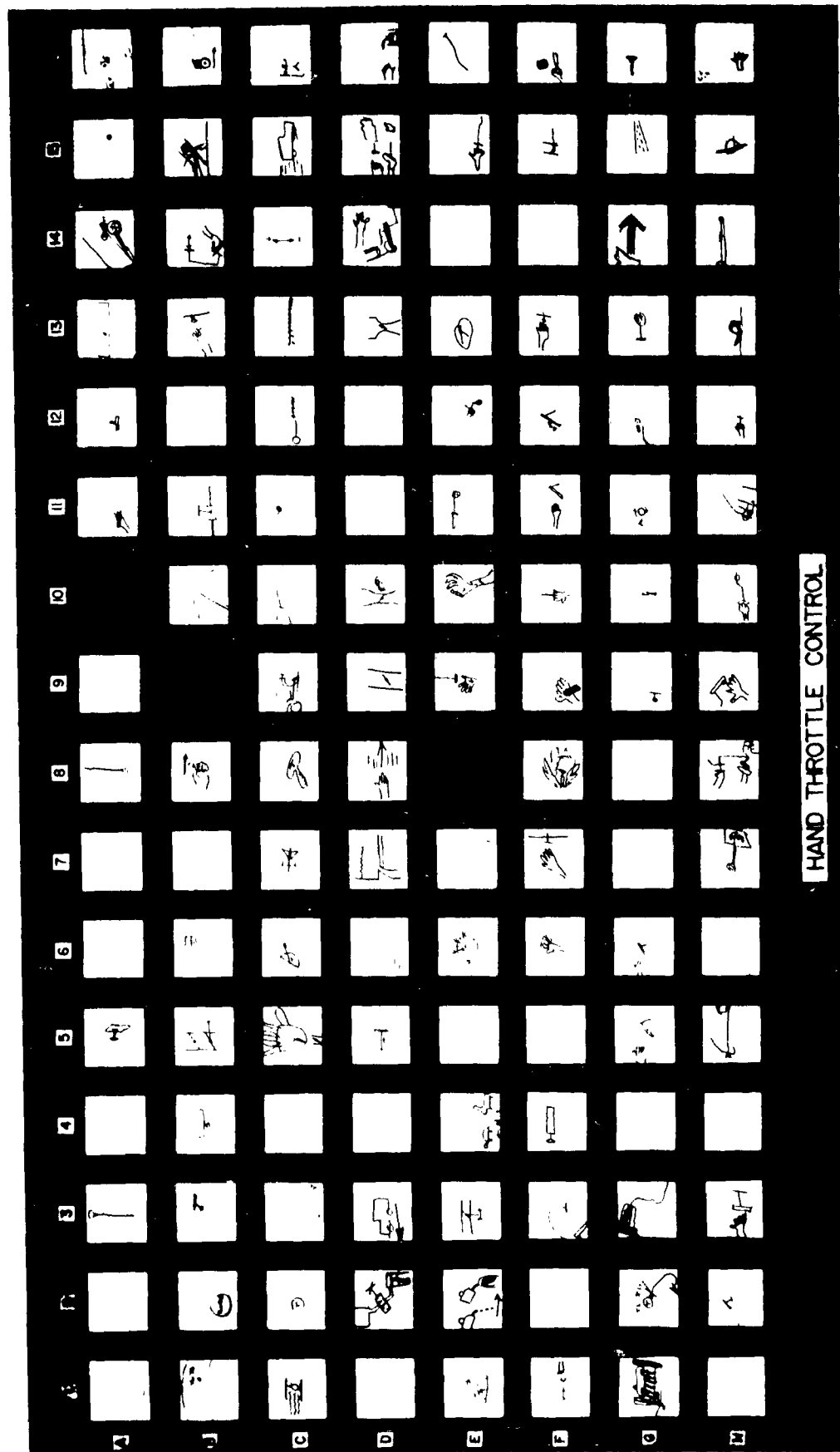
BATTERY SLAVE



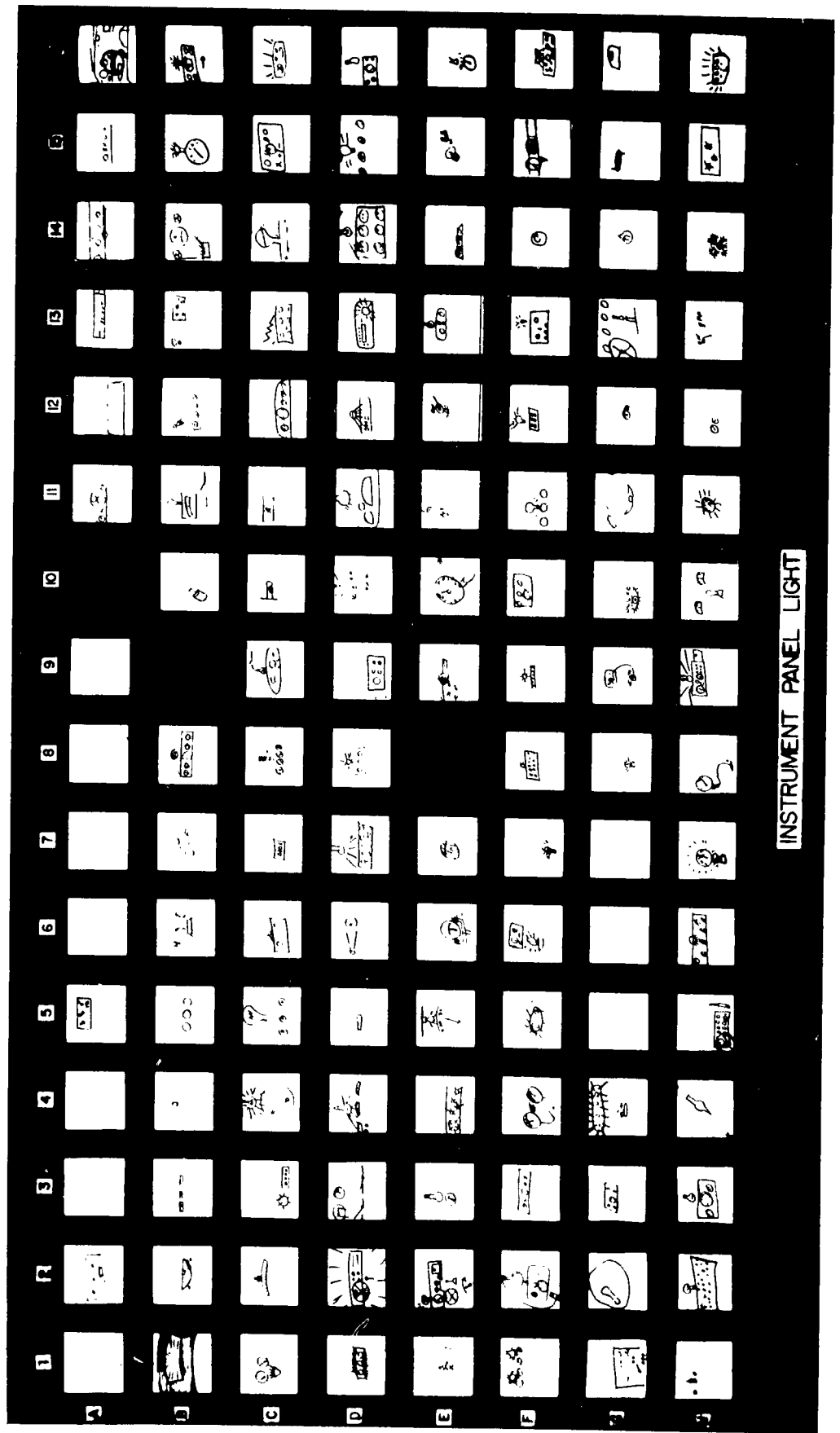
PRIMER PUMP



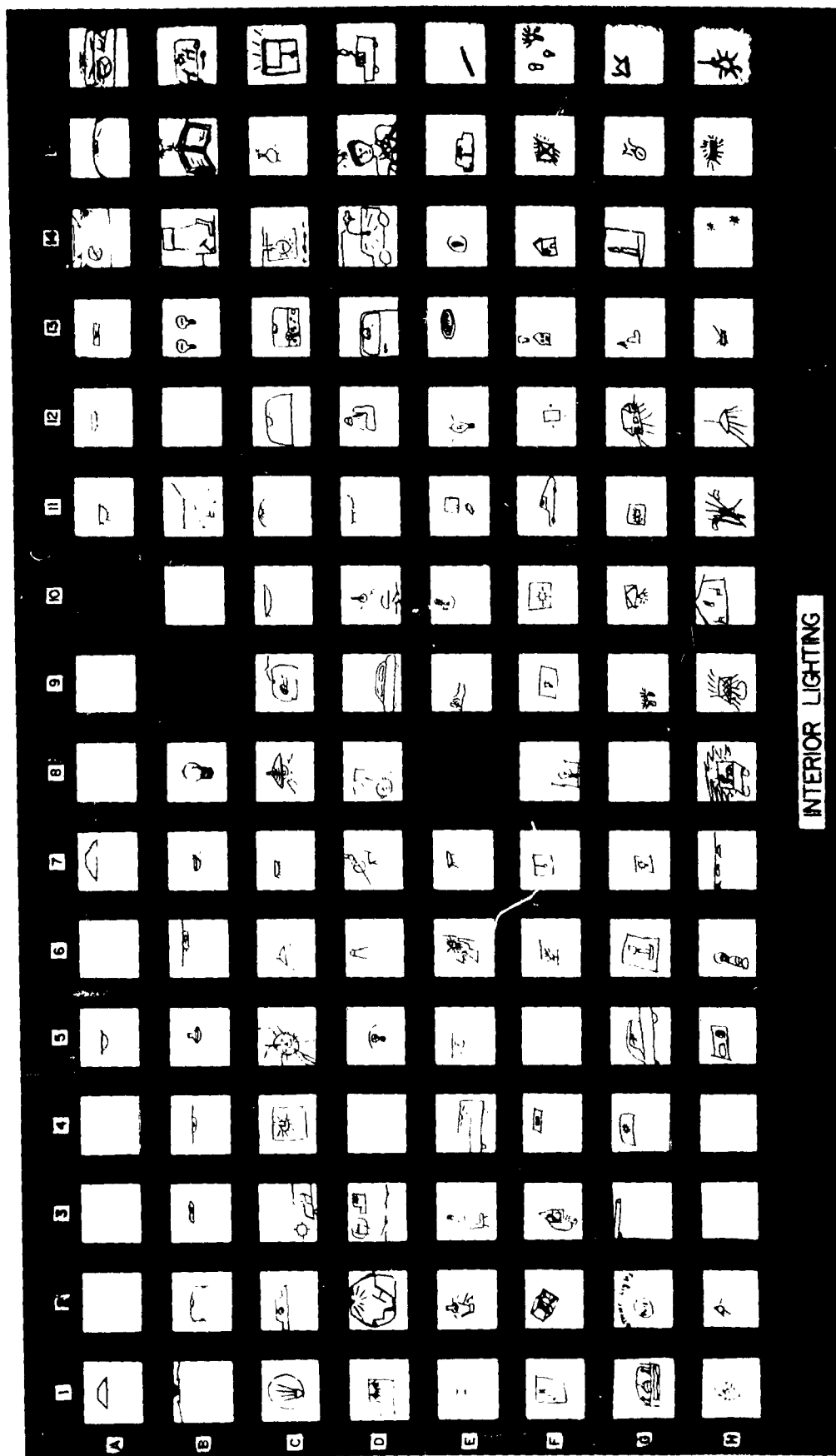
CHOKE

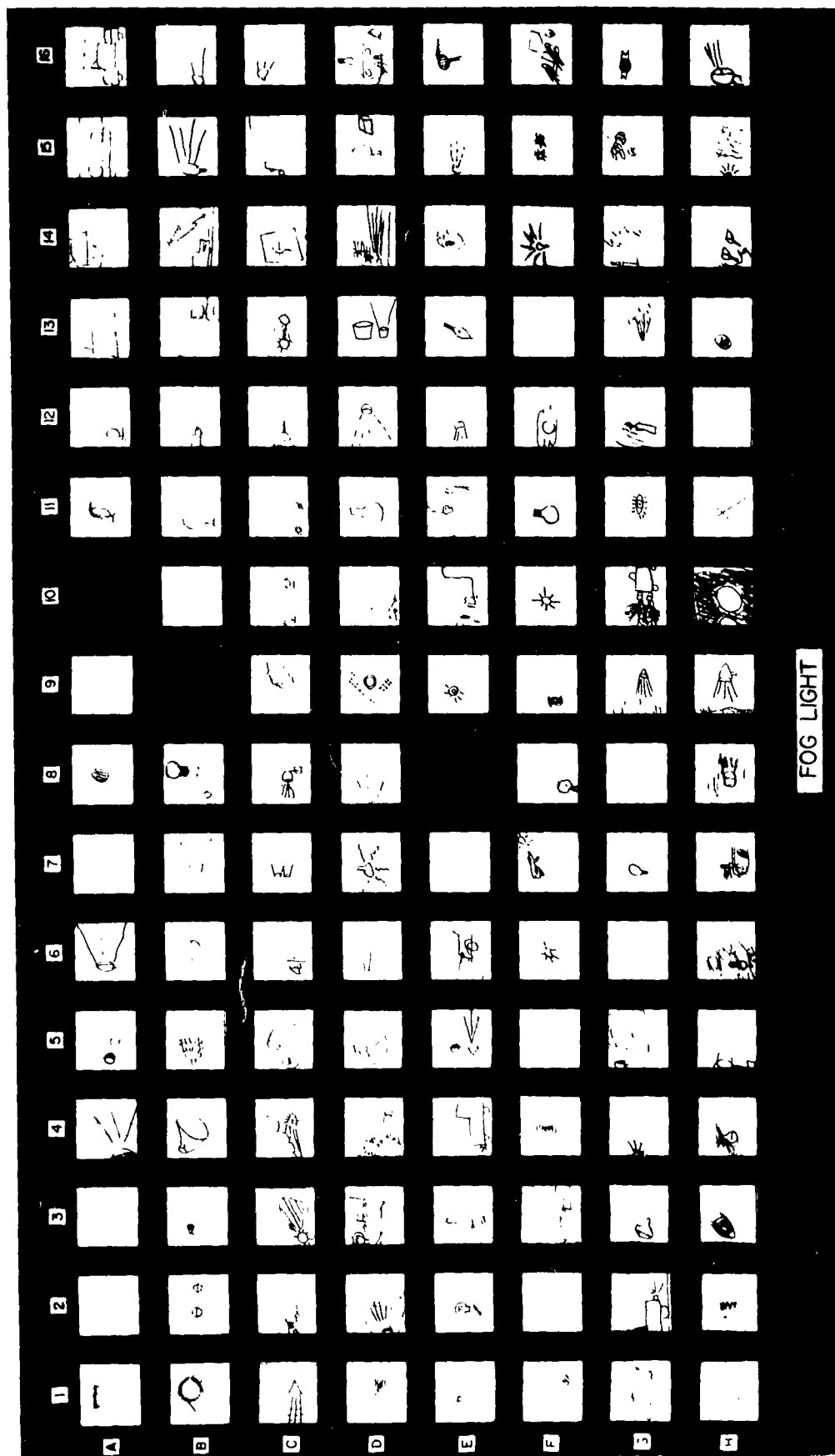


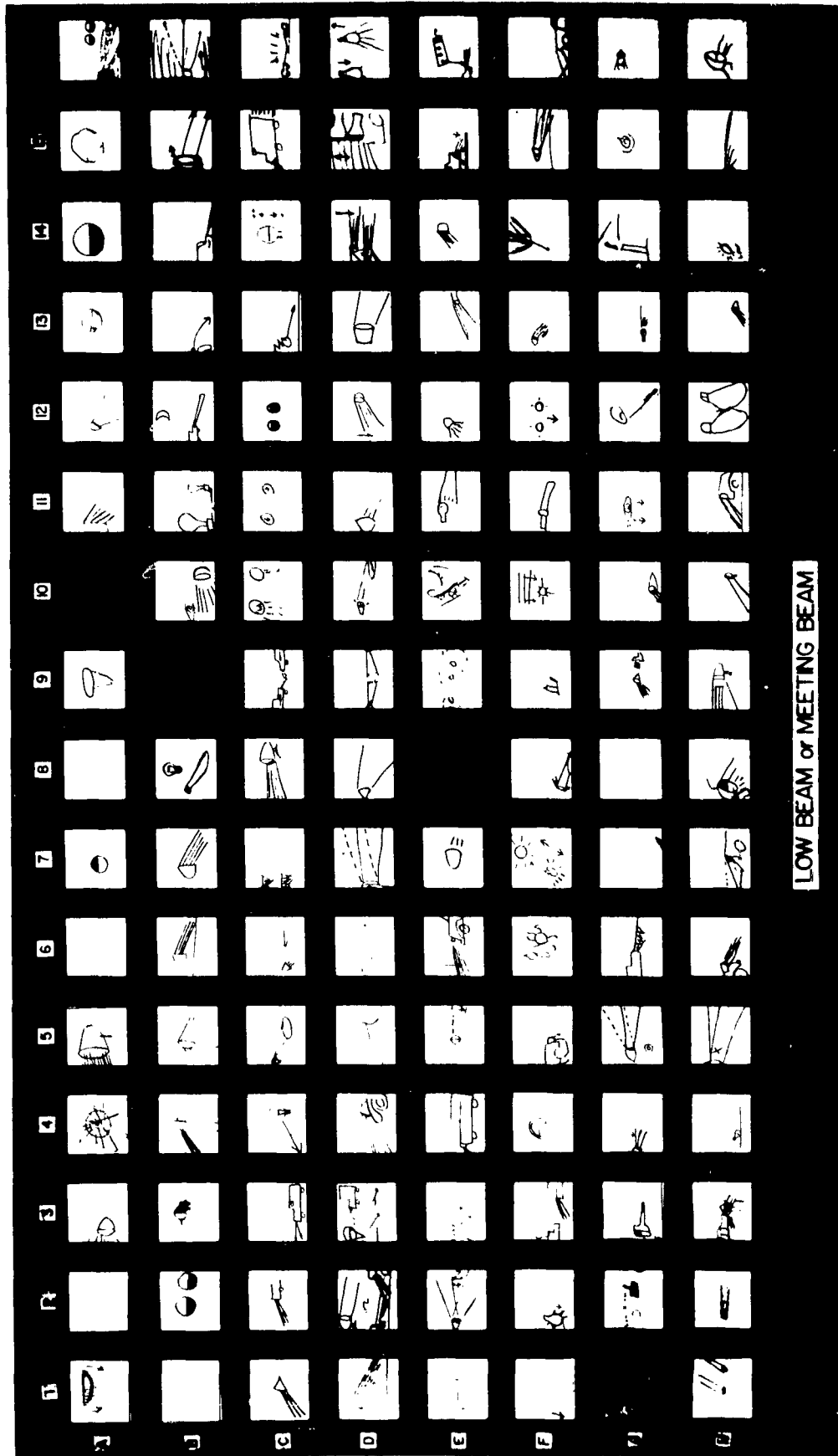
HAND THROTTLE CONTROL

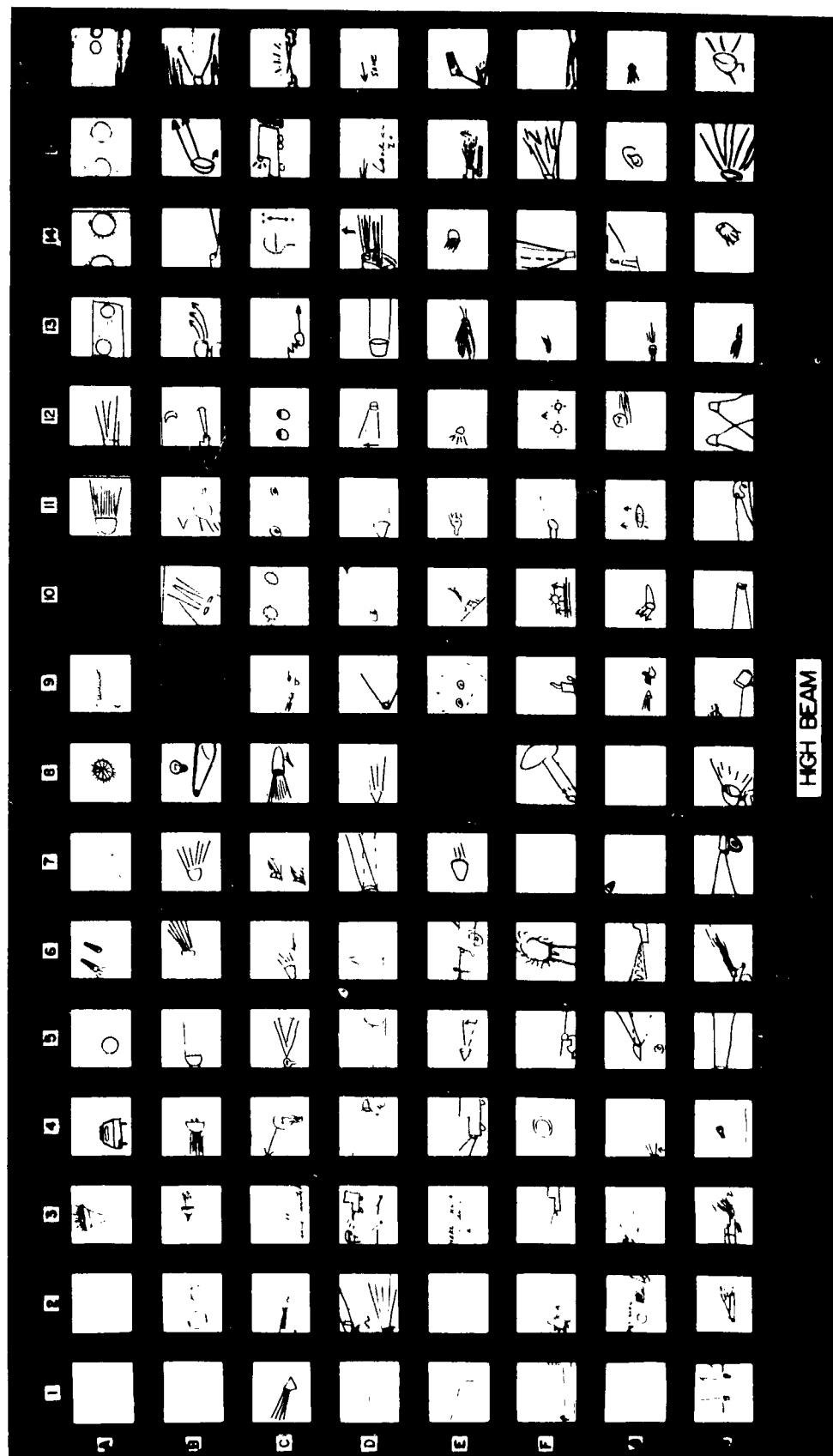


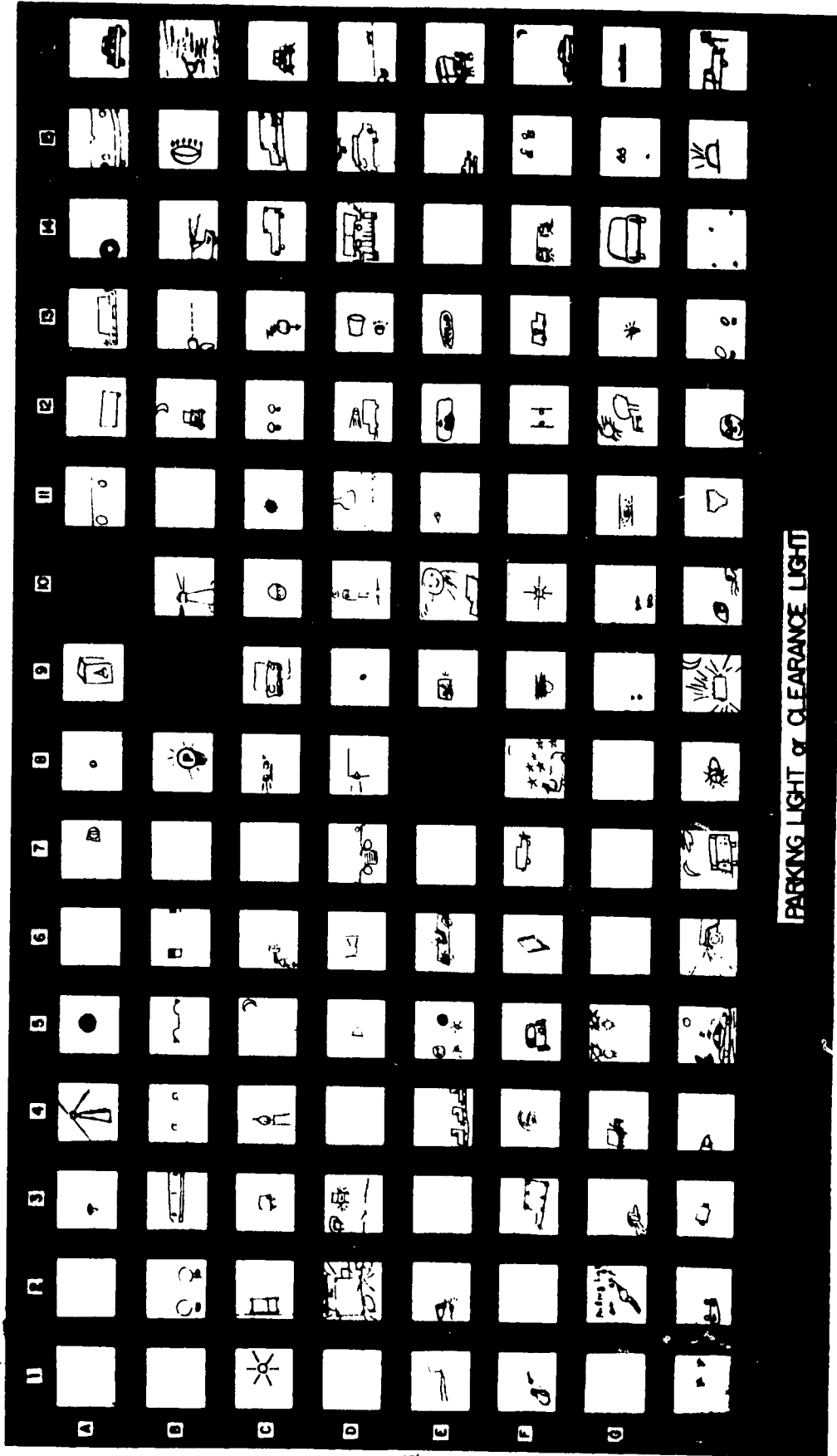
INSTRUMENT PANEL LIGHT



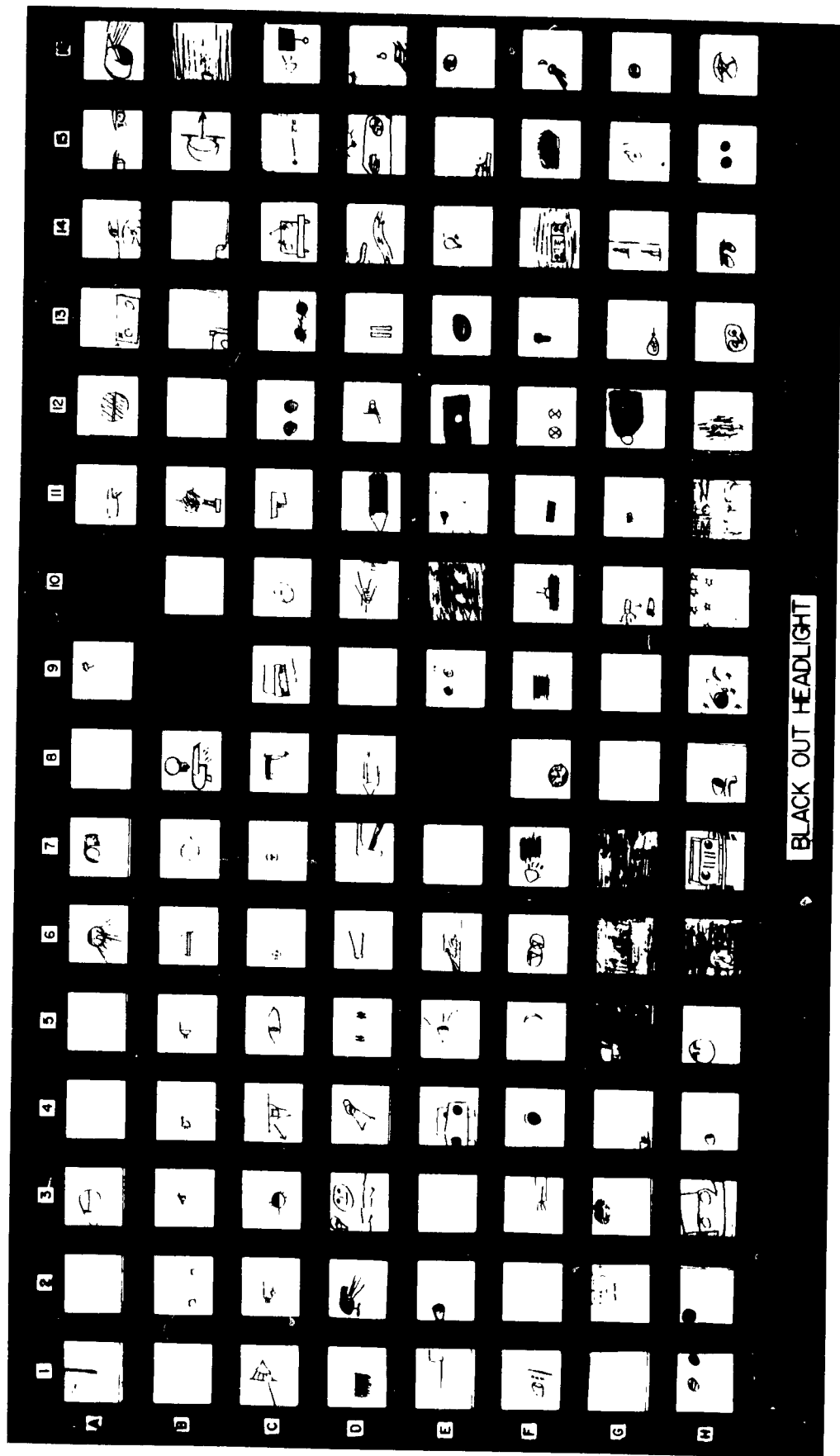


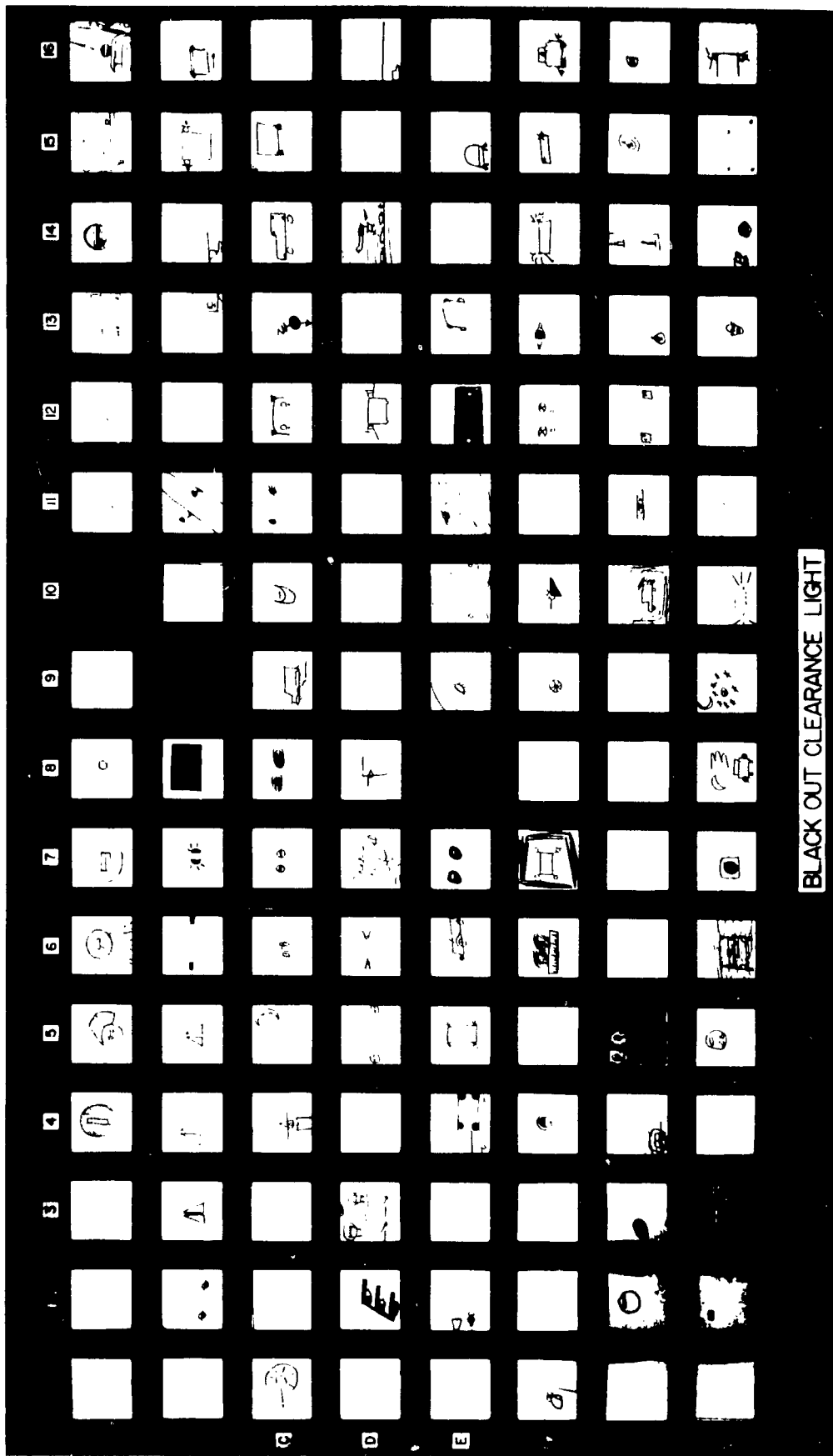






PARKING LIGHT & CLEARANCE LIGHT





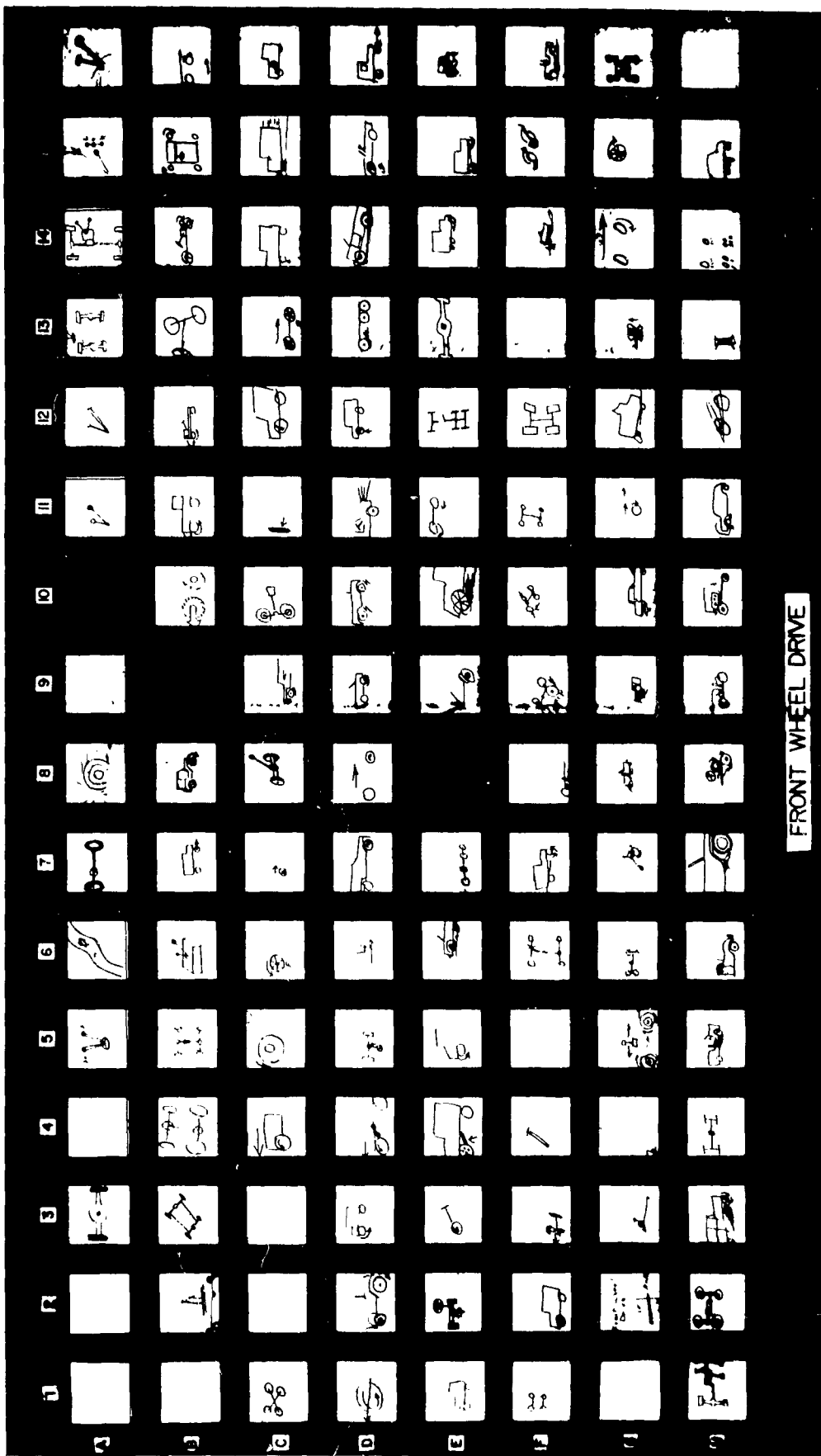
BLACK OUT CLEARANCE LIGHT

A	B	C	D	E	F	G	H
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

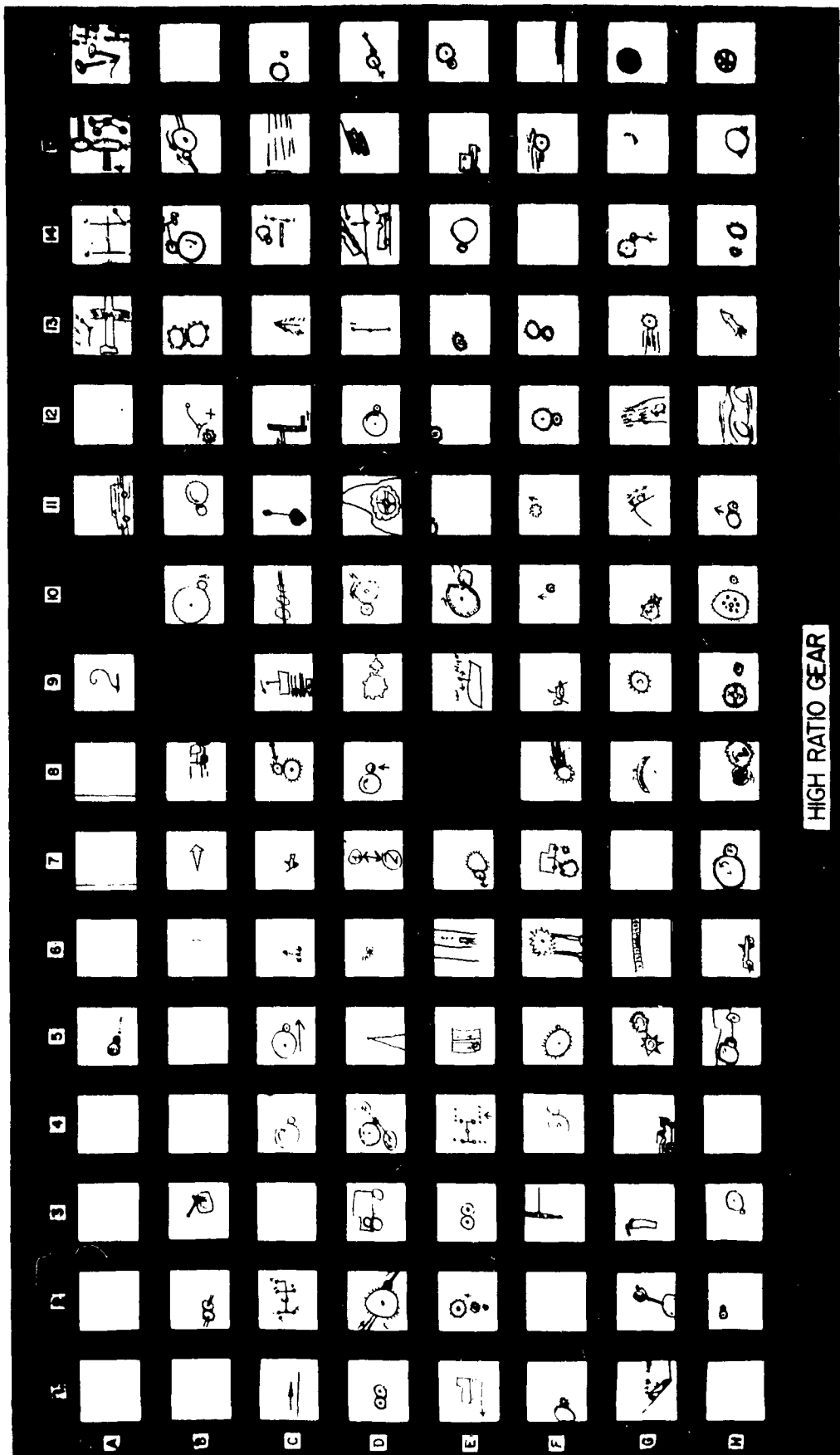
SNORKEL

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A																
B																
C																
D																
E																
F																
G																

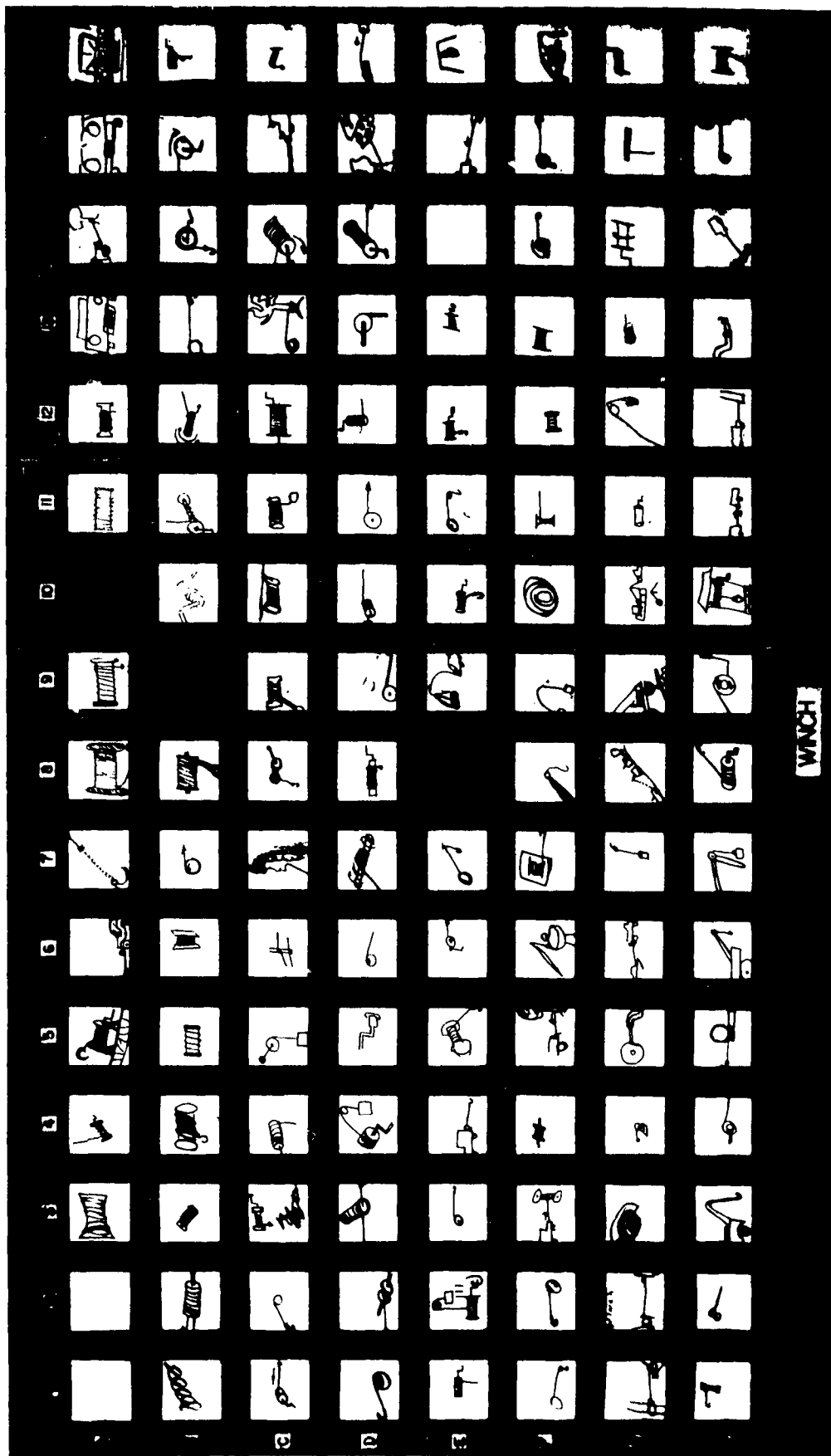
CLUTCH



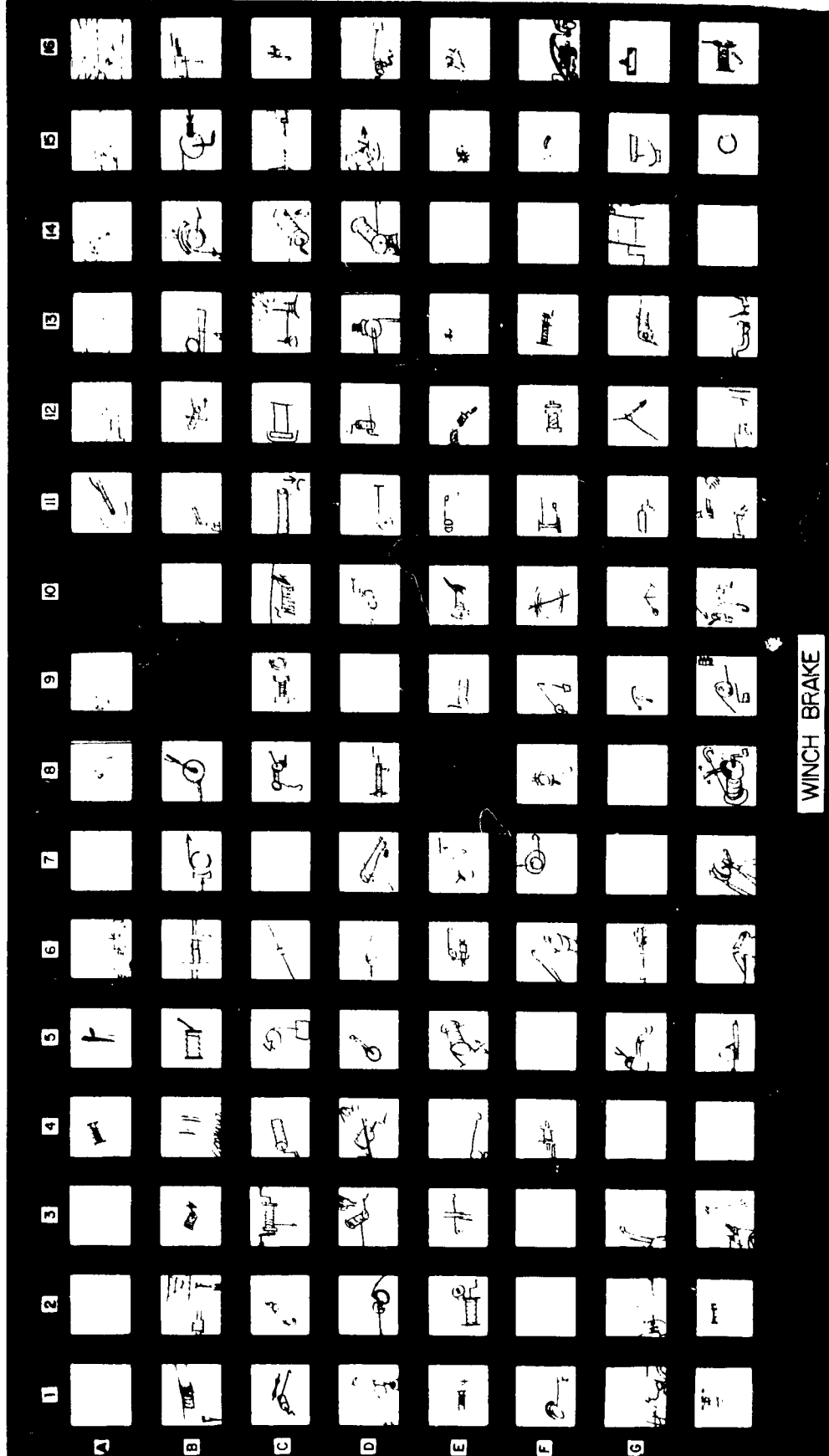
FRONT WHEEL DRIVE



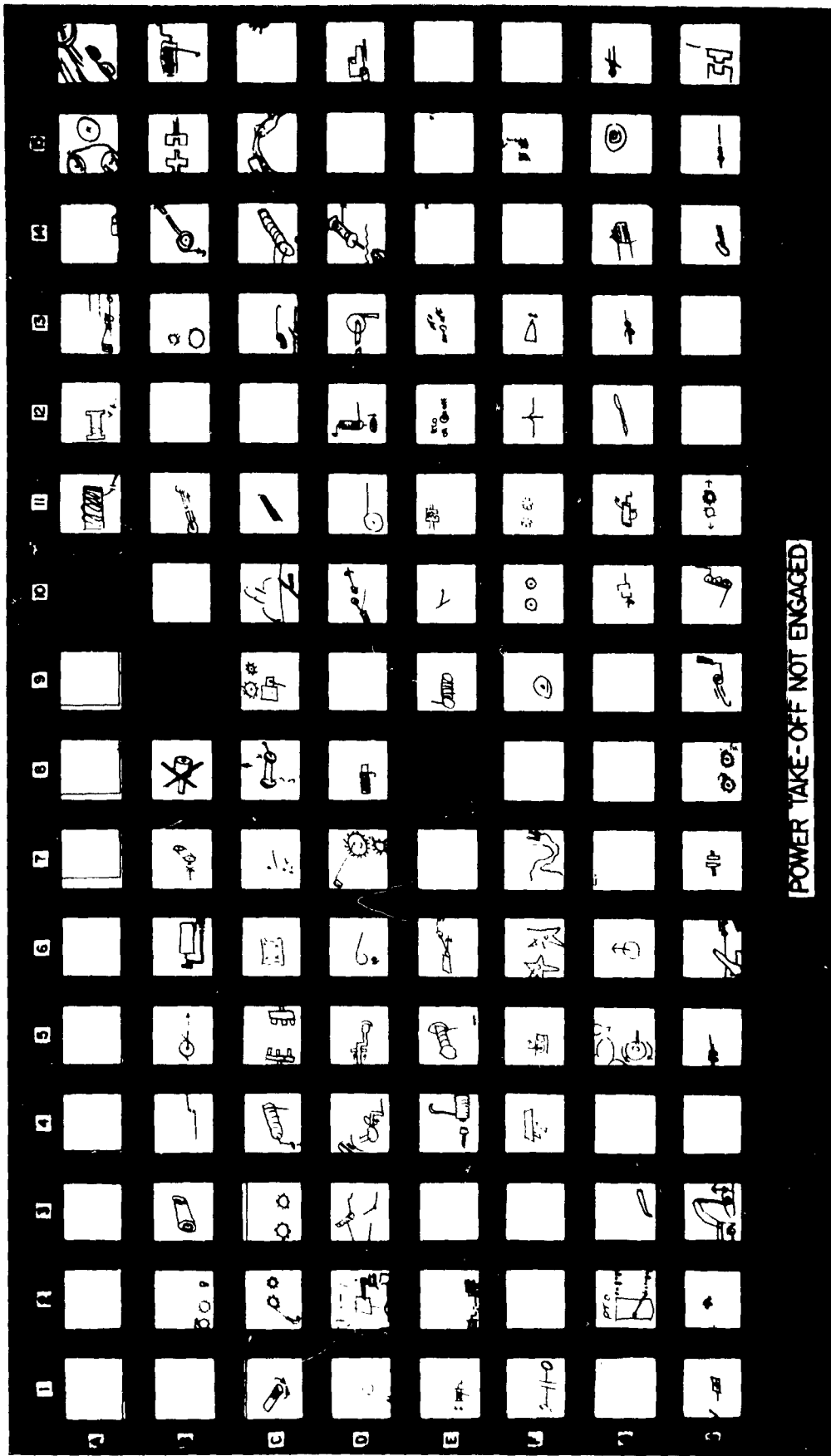
HIGH RATIO GEAR



WINCH



WINCH BRAKE



POWER TAKE-OFF NOT ENGAGED

APPENDIX C

FIRST-ORDER QUALITATIVE ANALYSIS (BY CONTROL) OF
VEHICLE SYMBOLOGY QUESTIONNAIRE RESPONSES

APPENDIX C

FIRST-ORDER QUALITATIVE ANALYSIS (BY CONTROL) OF
VEHICLE SYMBOLOGY QUESTIONNAIRE RESPONSES

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>		
1. HORN			Side view	2
	Omissions	3	w/window	0
			w/arrow	0
	Horn	91	w/window & arrow	0
	Type		Window alone	4
	animal	4	Abstract	3
	bulb	46	Wiper-arm axis orientation	
	electrical	37	Top	23
	music	4	Bottom	80
	Orientation		3. DIRECTION INDICATOR	
	right	76	Omissions	2
	left	15	One arrow shown	
	Non-horn	9	one head	17
	Sound shown	61	two heads	9
2. WINDSHIELD WIPERS			w/switch	1
	Omissions	10	Two arrows shown	76
	One Wiper Shown		w/switch	2
	Front view	8	vertical orientation	2
	w/window	31	Cross	3
	w/arrow	3	"Control" pictured	4
	w/window & arrow	6	Directional arm	
	Side view	25	mechanical	1
	w/window	1	human	1
	w/arrow	1	Compass	1
	w/window & arrow	0	w/arrow	1
	Two Wipers Shown		Pointing finger	1
	Front view	4		
	w/window	21		
	w/arrow	0		
	w/window & arrow	3		

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>
-------------------------	-------------------------	-----------------------------

4. RADIO

Omissions	4
Antenna/aerial w/cabinet	44 27
Cabinet w/dials	20 46
Dials	23
Electrical symbols	6
Hearing concept	6
Radio/sound waves	55

5. HEATER SWITCH

Omissions	11
Abstract	15
"Control" pictured	32
Electric heater w/switch	5 2
Fire w/switch w/ice w/switch & ice	12 2 1 2
Radiator w/wavy lines w/fan w/wavy lines & fan	3 4 1 1
Sun w/switch w/ice	13 3 6
Thermometer	4
Wavy lines w/switch w/fan	5 1 1

6. CAR HEATER REGULATOR

Omissions	21
Abstract w/arrows	4 1
Control w/arrows	20 8
Electric heater w/arrows	2 3
Fire w/arrows w/ice w/arrows & ice	3 5 2 1
Radiator w/arrows w/arrows & fan	2 2 2
Sun w/arrows w/ice w/arrows & ice	1 3 4 4
Thermometer w/arrows w/switch	3 3 1
Wavy lines w/arrows	7 3

7. CABIN VENTILATION

Omissions	13
"Air" shown w/fan w/duct w/control w/transom w/fan & duct w/fan & control w/arrows w/arrows & duct w/arrows & transom w/arrows & cabin	7 8 11 1 8 3 1 3 6 6 2

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>
-------------------------	-------------------------	-----------------------------

Cabin		4
"Control" pictured		2
Duct		6
w/arrows		3
w/arrows & cabin		4
Fan		13
w/arrows		1
Transom		14
*Use of arrows		
To indicate air flow		
straight arrows		8
wavy arrows		1
curved arrows		4
To indicate direction		
of flow		
straight arrows		7
curved arrows		3
*Depiction of air concept by		
Wavy lines		15
Straight lines		14
Cloud		7
Abstract		2

8. IGNITION SWITCH

Omissions		11
Abstract		8
Key		23
w/switch		3
w/keyhole		9
w/switch & keyhole		1
Lightning		14
w/switch		3
Points (distributor)		2
Spark plug		5
w/switch		3
Switch		38

9. STARTER

Omissions		20
Abstract		16
Circular arrows		6
"Control" pictured		26
Crank		29
w/arrow		7
Engaged wheels w/arrow		1
Fan blade w/arrow		2
Key		3
Motor		4
Spiral		2

10. SPARK ADVANCE

Omissions		24
Distributor		8
w/arrow		7
w/arrow & plug		1
Hand control		2
w/arrow		4
Lightning		7
w/arrows		24
w/control		1
w/points		3
w/arrows & points		2
Spark plug		8
w/arrows		9
w/arrows & control		2
w/arrows & points		1
w/arrows & spark		2
w/arrows & piston		1
w/piston & spark		5
Points		1
w/arrows		2

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>			
	Piston	2		"Control" pictured	6
	Spark w/arrow	3		Cylindrical pump	
	*Type of arrows used			Straight handle	36
	straight	36		w/spray	8
	rotary	21		w/arrow	3
11. BATTERY SLAVE				Extended handle	10
	Omissions	11		w/spray	1
	Abstract	6		Fuel pump, automotive	4
	One battery	6		Gas pump	1
	w/cable	4		Gravity pump	6
	w/plug	1		Spray	2
	w/cable & plug	2		Water well pump	14
	Two batteries	1		w/arrow	1
	w/two cables	44		w/butterfly valve	1
	w/one cable	5		w/spray	2
	Cable			*Type of handle shown	
	One	10		"T" shape	21
	w/two vehicles	2		knob	29
	Two	8	13. CHOKE		
	Control	1		Omissions	18
	Electrical symbols	8		Abstract	7
	w/cable	3		Butterfly valve	20
	w/arrows	1		w/control	2
	Lightning bolt	1		w/spray	1
	Plugs (connector)	5		w/venturi effect	5
	*Polarity of batteries shown	32		Constriction (abstract)	7
12. PRIMER PUMP				"Control" pictured	23
	Omissions	18		Noose	11
	Abstract	7		Spray	1
				Strangle (human)	24
				Venturi	3

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>		
14. HAND THROTTLE CONTROL				
Omissions		26	Two pipes w/valve	4
Abstract		13	w/valve & arrows	2
Butterfly valve in tube		2	w/switch	1
w/arrow		1		
w/hand		2	*Fuel level depicted	36
"Control" pictured		35	16. MAIN LIGHT SWITCH	
w/foot control		5	Omissions	11
Hand		3	Abstract	10
w/arrow		2	Light bulbs	1
w/control		19	Base up	
w/foot-pedal		7	w/emanations	3
w/control & arrow		1	w/emanations & switch	4
w/foot-pedal & arrow		1	Base down	3
Tank (container)		2	w/emanations	4
Valve		2	w/emanations & switch	2
*Type of handle shown			Key w/arrow	1
"T" shape		23	Lamp, top view	2
Knob		18	w/switch	2
15. FUEL TANK SELECTOR SWITCH			w/emanations	7
Omissions		12	w/emanations & vehicle	2
Abstract		2	Lamps, side view	1
"Control" pictured		27	w/emanations	14
w/arrows		2	w/emanations & switch	3
One tank		1	w/emanations & vehicle	1
w/arrows		1	Switch	31
w/switch		1	w/bulb, side view	8
Two tanks		7	& emanations	6
w/arrows		5	w/bulb, top view	5
w/valve		16	& emanations	1
w/switch		32	*Switch types used	
w/valve & arrows		5	Button	14
w/switch & arrows		8	Electrical symbol	24
			Key	1
			Knife	6
			Knob	9
			Lever	17
			Toggle	9

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>			
	*Orientation of bulb base			Lantern	1
	Up	9		w/emanations	1
	Down	25			
17. INSTRUMENT PANEL LIGHT				Sun	
	Omissions	10		w/emanations	1
	Abstract	3		w/interior	2
	"Control" pictured	8		w/man	1
	Instrument panel	10		*Interior type	
	Lit panel	20		"Box"	17
	Panel w/light bulb	15		Vehicle	24
	& emanations	48			
	Light	7		*Orientation of bulb base	
	w/emanations	3		Up	33
	*Panel w/light above	44		Down	17
	*Instrument layout		19. FOG LIGHT		
	on panel	61		Omissions	11
	not enclosed	34		Abstract	8
18. INTERIOR LIGHTING				Cloud effect	
	Omissions	14		Side view lamp	9
	Light bulb			w/lines	5
	Base up	2		Front view lamp	2
	w/emanations	7		w/lines	2
	Base down	5		Bulbs	5
	w/emanations	5		Dotted line effect	
	"Control" pictured	2		Side view lamp	1
	Light fixture	11		Front view lamp	1
	w/emanations	11		Droplet effect	1
	Interior shown			Gray field effect	
	w/emanations	2		Side view lamp	18
	w/fixture	4		Front view lamp	5
	w/bulb	4		Bulbs	15
	w/fixture & emanations	28		No fog effect	
	w/bulb & emanations	19		Side view lamp	19
				Front view lamp	12
				Bulbs	2

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>		
	Wave pattern effect		Field directed up	31
	Side view lamp	4	w/arrows	13
	Front view lamp	1	Field directed ahead	33
20. LOW BEAM			w/arrows	3
	Omissions	5	Lamp, front view	3
	Abstract	12	w/emanations	6
	Control	3	w/arrow	3
	Light	2	upper half shielded	2
	w/emanations	4	*Position of lower limit of light field	
	Field down	50	Horizontal	19
	w/arrows	21	Above horizontal	26
	Lamp covered		Below horizontal	32
	upper half	1	*Representation of light field	
	lower half	1	Outline	36
	Lamp covered (front view)		Filled in	50
	upper half w/arrows	1	22. PARKING LIGHT	
	lower half w/arrows	7		
	Vehicles meeting	8	Omissions	18
	*Lamp orientation		Abstract	15
	Side view	61	Circles	6
	Front view	14	w/emanations	2
	shielded	8	Clearance lights	9
	*Position of upper limit of light field		w/emanations	7
	Horizontal	20	w/vehicle	10
	Above horizontal	4	w/vehicle & emanations	17
	Below horizontal	55	"Control" pictured	1
21. HIGH BEAM			Lighthouse w/emanations	2
	Omissions	7	Lights	3
	Abstract	5	w/emanations	16
	Control	5	w/vehicle & emanations	7
	Lamp, side view		*Number of lights used	
	w/emanations	3	Single	42
	w/arrow	2	Pair	39

<u>Control</u> <u>Name</u>	<u>Element</u> <u>Used</u>	<u>Frequency</u> <u>of use</u>
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23. BLACKOUT HEADLIGHT

Omissions	13
Abstract	14
Circles	
w/slits	6
w/slits & emanations	5
Half blacked in (upper)	3
w/emanations	2
w/triangles	4
w/crosses	1
Blacked-in	3
w/emanations	2
Other	5
Lamps	3
w/emanations	4
w/black field	14
w/black field & emanations	4
Shielded lamp	8
Blacked-in	2
w/black field	2
w/emanations	11
Slits	2
Black slits	1
w/emanations	1
*Lamp orientation	
Front view	51
3/4 or side view	41

24. BLACKOUT CLEARANCE LIGHT

Omissions	34
Abstract	8
Circles	1
w/slits	5
w/emanations	1
Black on white	1
w/slits	4

Clearance points	4
Black on white	4
w/emanations	1
White on black	4
w/emanations	1

Lights	
w/emanations	2
Black on white	3
w/emanations	2
White on black	1
w/emanations	1
w/shields	1

Triangles	3
White on black	3

Vehicle clearance points	
w/emanations	13
Black on white	9
w/emanations	5
White on black	1
w/emanations	2

25. SNORKEL

Omissions	11
Curved tube	9
w/arrow	1
mounted on vehicle	1
breaking water	36
mounted & breaking water	21

Straight tube	5
mounted on vehicle	6
breaking water	10
w/arrow	1
mounted & breaking water	18
w/arrow	3

*Relation of tube to water line	
Above only	11
Through	63

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>
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26. CLUTCH

Omissions	19
Arrows	2
Clutch	
w/engine	3
& pedal	1
& arrow	2
One clutch plate	
Front view	9
w/pedal	2
w/arrow	1
w/pedal & arrow	1
Side view w/pedal	2
Two clutch plates,	
side view	17
w/arrow	21
w/pedals	4
w/pedals & arrow	6
Gears	2
w/arrows	3
Hand	4
w/control	1
*Use of arrows to depict	
Shaft rotation	9
Movement between plates	4
Both of above	10

27. FRONT WHEEL DRIVE

Omissions	12
"Control" pictured	8
One wheel	2
w/arrow	10

Two wheels	3
w/arrow	8
w/axle	5
w/axle & arrows	5
w/vehicle	9
w/vehicle & arrows	33
w/frame	1
w/frame & arrows	1

Four wheels	1
w/frame	18
w/frame & arrows	4

*Type of arrow used	
Rotary	30
Straight	15
Both	12

28. HIGH RATIO GEAR

Omissions	20
Abstract	8
"Control" pictured	2
w/label & arrow	1
Gear	5
w/arrow	2
w/control	1
w/label	2
w/speed depicted	3
Gear ratio, full view	
Engaged gears	15
w/arrow	25

Disengaged gears	7
w/arrow	2

Gear ratio, edge view,	
engaged	1
w/arrow	1

Shift pattern	
w/label	4
w/label & control	3
w/gear ratio	1
w/arrow	1

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>			
	Speed concept depicted	9		Two arrows	41
	w/control	1		w/labels	4
29. NEUTRAL				Clothing	4
	Omissions	16		Containers	3
	Cancellation concept	3		w/arrows	2
	w/arrows	9		Theological	1
	w/gear & stick control			Topographic	1
	device	1		w/arrows	3
	One gear			*Spatial relationship of two	
	w/label	1		arrows	
	w/opposing arrows	1		Parallel	14
	Two gears, disengaged	19		"in-line"	31
	w/stick control	6	31. WINCH		
	w/opposing arrows	9		Omissions	3
	w/arrow	6		Winch, front view	23
	Shift pattern	4		w/arrow	4
	w/labeling	10		w/handle	11
	w/stick control	5		w/handle & arrow	8
	w/stick control & label	7		w/hook	11
	w/stick control & arrows	1		w/handle & hook	8
	Stick control	5		w/handle & hook & arrow	1
	w/label	1		Winch, side view	8
	w/arrows	4		w/arrow	4
	"Zero"	3		w/handle	6
30. TOP-BOTTOM				w/handle & arrow	2
	Omissions	16		w/hook	15
	Abstract	12		w/hook & arrow	2
	Anatomical	10		w/handle & hook	3
	w/arrows	6		w/handle & hook & arrow	2
	One arrow			w/control	1
	Head up	2		w/control & arrow	1
	w/label	1		Cable	2
	Two heads	6		w/arrow	3
	w/labels	2		w/hook	2
				*Orientation of arrows	
				Rotation of winch	15
				Along cable	8
				Both	3

<u>Control Name</u>	<u>Element Used</u>	<u>Frequency of use</u>			
32. WINCH BRAKE					
	Omissions	17		Motor w/arrow	1
	Brake			Towing scene	3
	w/winch	19		Turning axles	6
	w/winch & arrow	6		w/gears	2
	w/control	1		w/arrow	5
	w/winch & control	15		Winch	8
	w/winch, control & arrow	7		w/gears	3
	"Control" pictured	9		w/cable	2
	w/arrow	1		w/cable & arrow	15
	Winch	10		w/engine	2
	w/arrow	1			
	w/control	13		34. POWER TAKE-OFF NOT ENGAGED	
	w/control & arrow	6		Omissions	34
	w/handstop	4		Belt drive	3
	Broken winch or cable	11		"Control" pictured	11
	*Views of winch			Drive assembly	9
	Side	41		Gears	9
	Front	51		w/arrows	3
	*Brake types used			w/belt	1
	Lever controls	19		Motor	2
	Shoe brake	37		Towing scene	1
	Stop brake	24		Turning axle	4
	"Broken" spool/cable	17		w/winch	1
				w/arrows	5
33. POWER TAKE-OFF ENGAGED				Winch	11
	Omissions	30		w/broken cable	4
	Belt drives	2		w/cable	2
	w/arrows	2		w/broken drive	6
	"Control" pictured	12		w/gear	4
	Drive assembly	5		w/arrows	2
	w/arrows	1			
	Gears	8			
	w/hook	1			
	w/arrow	4			
	w/belt	1			
				NOTE: * Frequency counts in this category are based on all 125 responses regardless of their previous categorization within the control label group.	

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Mr. Wesley F. Woodson
Mail Zone: 504-50
General Dynamics/Astronautics
5001 Kearny Villa Road
San Diego 11, Calif. 1 cy

Canadian Army Staff (Washington)
2950 Massachusetts Ave., N.W.
Washington 8, D. C. 1 cy

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AD USA Ordnance Engineering Laboratories
Aberdeen Proving Ground, Maryland
DESIGN OF A PICTURE LANGUAGE TO IDENTIFY VEHICLE
CONTROLS - I. GENERAL METHOD - II. INVESTIGATION OF
POPULATION STEREOTYPES, Samuel A. Mudd & Robert Marsh
Technical Assistance of Warren Von Uffel
Tech Memo 22-61
Unclassified

UNCL

1. Vehicle Controls
2. Picture-Symbols, Vehicle
3. Population Stereotypes
Vehicle Controls
4. OCS Code 5010.11.8JA
5. TM 22-61

Accession No.

I. GENERAL METHOD - A general approach to the problem of developing a picture language or set of picture-symbols, as labels for equipment controls, is discussed. Negative and positive arguments for such a system of symbols and possible research strategies are considered.

II. INVESTIGATION OF POPULATION STEREOTYPES - The results of the first of a series of studies are reported. United States and foreign military personnel were asked to make line drawings that might convey the meaning of various wheeled-vehicle controls. These drawings were subjected to a qualitative analysis to extract common design elements. A preliminary set of 31 symbols, based on the resultant design elements, is presented. Recommendations for further research are included.

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